Iron AND Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

SEPTEMBER, 1956

TECHNOLOGY DEPT.

TABLE OF CONTENTS, PAGE 73

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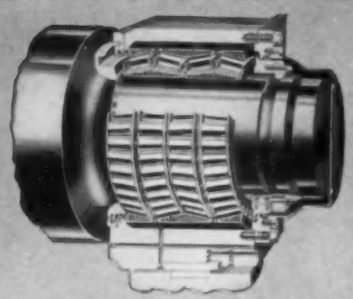


Timken Balanced Proportion bearings on back-up rolls and work rolls insure minimum maintenance, extreme precision, longer life.

2-high bloom and slab mill starts faster, drives easier on TIMKEN® balanced proportion bearings

WITH the roll necks on this 2-high bloom and slab mill—built by United Engineering & Foundry Company for Pittsburgh Steel's Monessen, Pa., plant—mounted on Timken® balanced proportion bearings, friction is practically eliminated. This means lower starting resistance, faster acceleration, easier roll drive and higher rolling speeds. And because the balanced proportion design of Timken bearings permits larger diameter roll necks with no increase in bearing O.D., roll neck strength is increased up to 60%—load ratings up to 40%.

No special thrust bearings are needed; Timken bearings take radial and thrust loads in any combination. And full line contact between the rollers and races of Timken bearings gives them extra load-carrying capacity. Complicated lubrication systems are eliminated, too; Timken bearings permit simple, economical grease lubrication. Rolls can be changed quickly and easily. Wear is greatly reduced, long life is assured. Timken bearings are designed geometrically to *roll true* . . . and are precision-manufactured, under the most rigid quality controls, to conform to their design. Timken bearings show lowest cost per ton of steel rolled.

Always specify Timken balanced proportion roll neck bearings. For full details, consult our roll neck specialists. Write to: The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

See us at the IRON AND STEEL EXPOSITION, Sept. 25-28, Public Auditorium, Cleveland, Ohio, BOOTH Nos. 134, 135, 136, 137

TIMKEN TAPERED ROLLER BEARINGS ROLL THE LOAD

TRADE-MARK REG. U. S. PAT. OFF.

CHOICE OF THE MILL INDUSTRY...
CUTLER-HAMMER'S 505 AISE D-c BRAKE

★ Simplified Design ★ Rugged Construction ★ Dependable Performance
★ Ease of Installation and Maintenance

Compare the Cutler-Hammer 505 D-c Brake with any other, and instantly you will appreciate why the 505 is the choice of the mill industry. The service proven over-the-wheel pull rod is the simplest means of transmitting the maximum braking force. Notice only one operating coil, only one torque spring, and only one torque adjustment. Gone is the clutter and multiplicity of pins, linkages and cantilevers common to other brakes. This is simplicity . . . simplicity in design and construction which insures you simplicity in operation, installation and maintenance. It is common sense the cleaner the design, the less complicated the design, the more dependable the performance . . . and in the Mill Industry dependable performance is paramount.

Each of the ten major components of the Cutler-Hammer 505 D-c Brake embodies the principle of rugged construction. Check the shoe-lever and base plate joints. Here troublesome pivot pins have been eliminated, and replaced by oversize bearing sockets which cut bearing pressure to a fraction of that found in other mill brakes. The tough, weatherproof capsule coil will out-perform all others. The brake shoes have heavy duty riveted linings. The wheel is specifically designed for braking service using only the finest high strength ductile iron. Ductile iron has superior wear characteristics and will not flake even at high temperature service.

Because of the simplified design and rugged construction it is natural to expect dependable performance, and you get it with the Cutler-Hammer 505 D-c Brake. The 505 is direct-acting, and exclusive one-to-one leverage provides maximum braking effectiveness.

CUTLER-HAMMER
MOTOR CONTROL
C-H

Take each feature of the 505 separately or all collectively; the C-H 505 D-c Mill Brake was designed and built to out-perform, out-last all others.

Ease of installation and maintenance is a major consideration in any device destined for mill application. Here too the Cutler-Hammer 505 is the choice of the industry. Because of the simplified design and minimum number of parts, the 505 can be completely assembled in a matter of minutes with ordinary hand tools. Capsule coil can be quickly changed or reversed while on the job. Only two adjustments required to put the brake into operation. Brake linings can be serviced quickly without disassembly of the brake. No special tools required for any maintenance operation.

For complete information write for the descriptive literature detailing construction, torque ratings, types, sizes and service characteristics. CUTLER-HAMMER, Inc., 1255 St. Paul Avenue, Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ontario.

IRON AND STEEL ENGINEER; published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., Pittsburgh, Pa. Second class mail privileges authorized at Pittsburgh, Pennsylvania, January 25, 1924.

AETNA'S

new ideas

IN SEAMLESS, BUTT WELD,
GALVANIZING TINNING,
DRAWBENCHES, CLASSIFYING

are making news

AETNA • STANDARD

THE AETNA-STANDARD ENGINEERING COMPANY

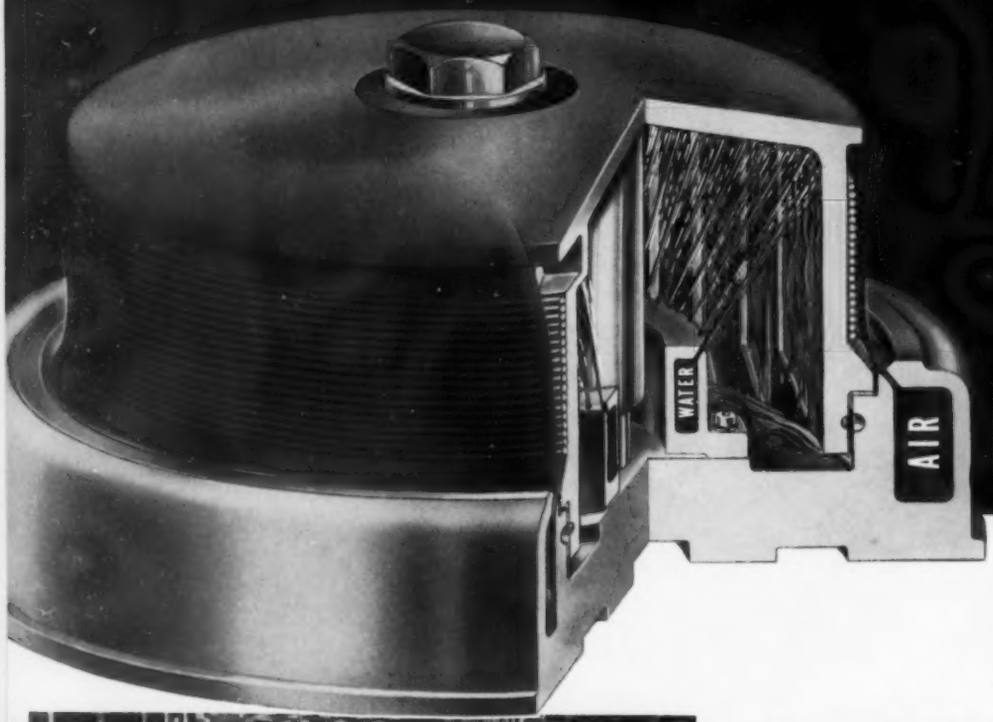
GENERAL OFFICES: PITTSBURGH, PA. PLANTS: ELLWOOD CITY, PA., WARREN, OHIO

CONTINUOUS GALVANIZING LINES • CONTINUOUS ELECTROLYTIC TINNING LINES • SIDE TRIMMING AND SHEAR LINES AND OTHER FINISHING EQUIPMENT • CONTINUOUS BUTT WELD PIPE MILLS • SEAMLESS TUBE MILLS • DRAWBENCHES AND OTHER COLD DRAW EQUIPMENT • ROLLS AND CASTINGS • EXTRUDERS, MILLS, PRESSES FOR RUBBER AND PLASTIC

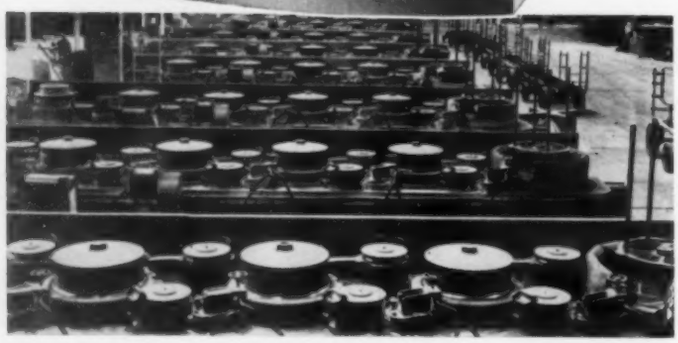
Vaughn® MOTOBLOC® MOTOBLOX®

Double-Cooled

with AIR and WATER



for perfect wire condition from start to finish!



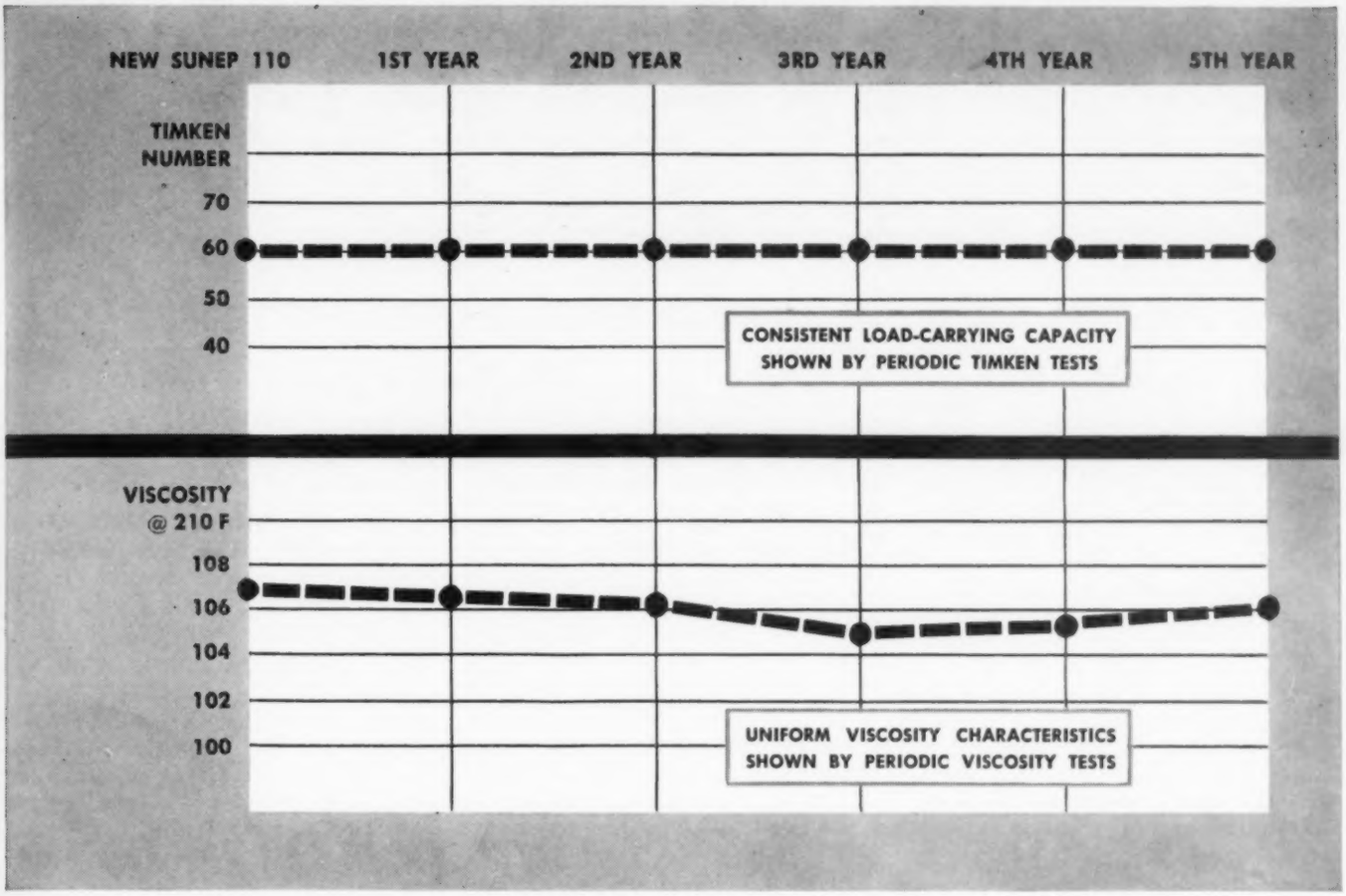
Vaughn DOUBLE-COOLED blocks insure desirable temperatures for high carbon wire all the way through the draw—thanks to advanced engineering that provides *both* air and water cooling. Each block is equipped with an annular air blast for external cooling of the wire, while water jets impinging on the inner finned block walls remove heat continuously and effectively.

• ***Let us discuss the benefits to your wire on your operation!***

The Vaughn Machinery Co., Cuyahoga Falls, Ohio, U. S. A.

"Quick on the Draw!"

COMPLETE COLD DRAWING EQUIPMENT . . . Continuous or Single Hole . . . for the Largest Bars and Tubes . . . for the Smallest Wire . . . Ferrous, Non-Ferrous Materials or their Alloys.



Taken from the records of a major steel producer, the above graphs show the life record of a Sunep gear lubricant used in a 3-stand, 4-high cold-rolling mill. *With no make-up,* Sunep is as good as new after running more than 30,000 hours.

Steel company tests show:

SUNEP EXTREME-PRESSURE LUBRICANT REDUCES OIL AND MAINTENANCE COSTS

Sunep® lubricants help cut over-all oil costs because they have a long service life. They are made from high-quality base oils...unusual in the manufacture of extreme-pressure lubricants ...and because of this, are outstanding in their resistance to oxidation. They will not thicken or thin out in operation and will separate easily from water. Most important, they will last years longer than ordinary gear lubricants.

Sunep lubricants help keep maintenance down because they don't lose their e.p. qualities. They are specially blended to prevent "fall-out" of the extreme-pressure ingredients in service...a frequent and hidden cause of gear failure.

Sunep lubricants protect bearings and gears against rust and corrosion...an added help in reducing maintenance costs.

For more proof that Sunep and other Sun Products can benefit you, visit Sun's booths 118, 119 and 120 at the Iron and Steel Exposition, Cleveland Public Auditorium, September 25–28.

INDUSTRIAL PRODUCTS DEPARTMENT

SUN OIL COMPANY

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IN CANADA: SUN OIL COMPANY LIMITED, TORONTO AND MONTREAL

SUNOCO®

GENERAL ELECTRIC *Control*

For fast, accurate performance, low operating costs, specify General Electric d-c control for your crane

If you're looking for the ultimate in crane control—from high-speed lowering to pin-point spotting, you want General Electric d-c crane control!

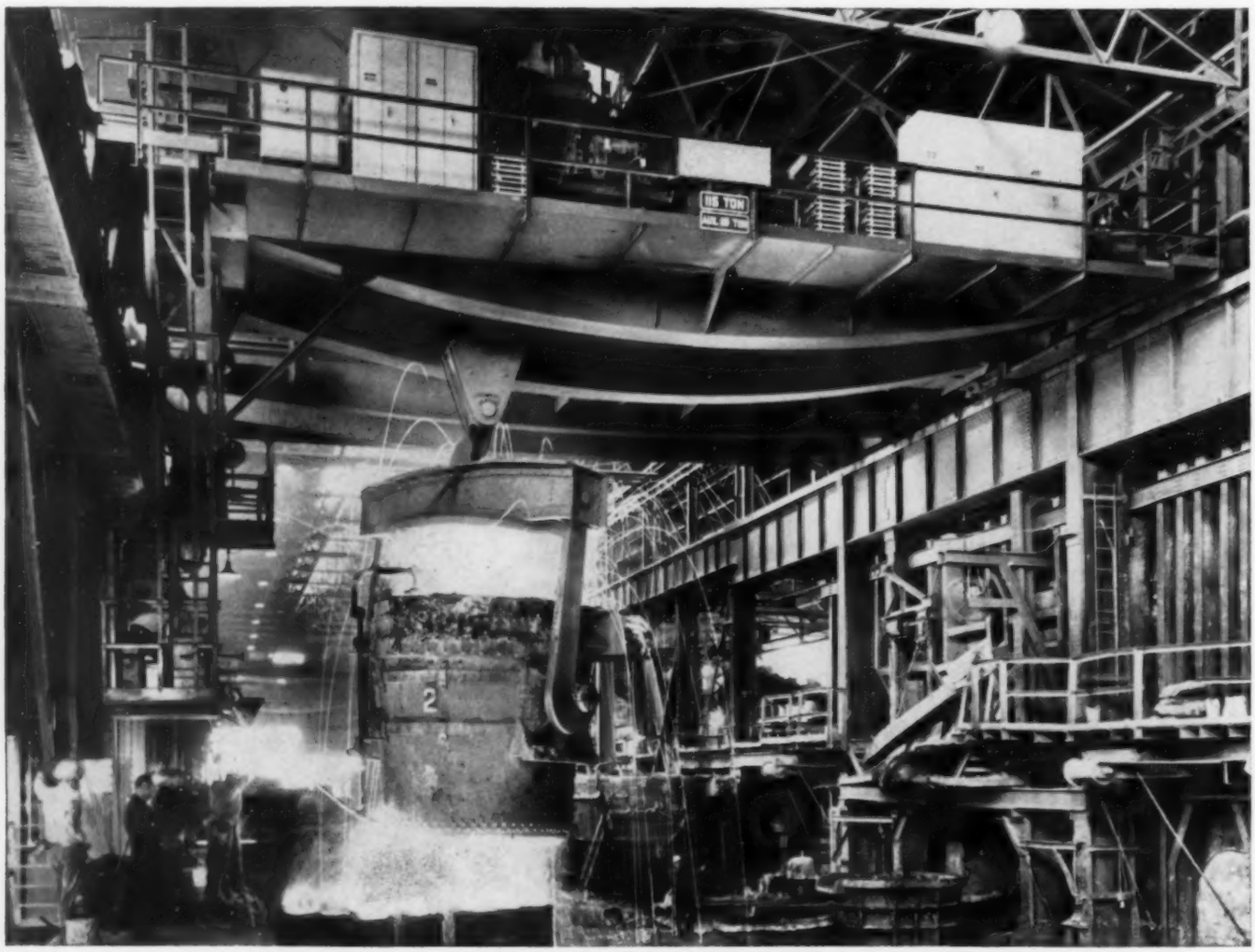
In designing the complete electrical system of your crane, G-E engineers work closely with your crane manufacturer to assure completely co-ordinated equipment. This integration of all mechanical and electrical components assures you of top crane operation, minimum downtime, and lower over-all operating costs. And because G.E. has a complete line of crane controls you are certain to get performance tailored to your specific operation.

ACCURATE HOIST CONTROL for every speed and load is assured with G-E d-c drives. Operational features, such as, five distinct speed points, dynamic braking, automatic acceleration and deceleration, and non-cycling operation provide you with a fast, efficient system.

PRECISION BRIDGE AND TROLLEY CONTROLS offer automatic acceleration, smooth reversal of motion without motor overload, and built-in automatic protection against motor overloading.

MINIMUM REPLACEMENT is required with General Electric d-c crane control. Each control component is tested under severe operating conditions and proved for the job before delivery.

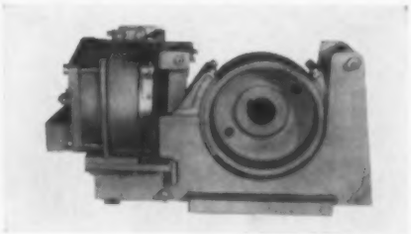
TAKE ADVANTAGE of these benefits by specifying G-E control for your next crane. Your G-E sales engineer will be happy to work with you and your crane manufacturer to engineer the right drive system. Industry Control Dept., General Electric Co., Roanoke, Va.



News for the steel industry

These G-E control products have top features for steel mill use:

DC BRAKES



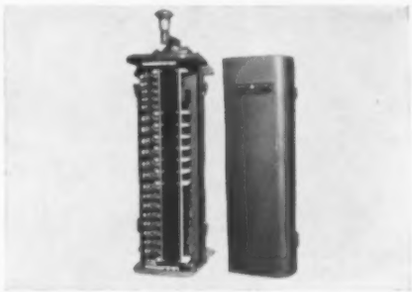
SINGLE POINT ADJUSTMENT—only one adjustment is needed to regulate lining wear on both brake shoes.

REMOVABLE LININGS—linings can be replaced in minutes, without removing the entire shoe assembly.

ARMATURE GAP INDICATOR—easily visible indicator shows when to adjust for lining wear.

MANUAL RELEASE—a simple and convenient method is provided for manually releasing the brake.

DRUM SWITCHES



DOUBLED CONTACT LIFE—each contact is reversible and may be turned to receive wear on each side, thereby reducing replacement costs.

FAST EASY INSTALLATION—conduit boxes have knockouts in bottom, sides, and back to simplify installation.

REDUCED MAINTENANCE TIME—easily removable covers allow complete access to all working parts.

INTERCHANGEABLE MECHANISMS—standard horizontal handle may be replaced by rope wheel, vertical handle, or switchboard mechanism.

LIMIT SWITCHES

HEAVY DUTY CONSTRUCTION—able to stand up under punishment of severe shock, vibration, moisture, and dust conditions.

REDUCED MAINTENANCE—there are no shunts or drum-type segments to replace or maintain.

LONG LIFE—each double-break, silver contact is independently adjustable for opening and closing.

SIMPLE TO CONNECT AND ADJUST—cover is easily removed to allow access to terminals plus ample wiring space for conduit connection.

MASTER SWITCHES

RUGGED CONSTRUCTION—cast-aluminum cover protects cams and contacts from dirt and dust and accidental rough handling.

FLEXIBLE—may be used with reversing or non-reversing controllers and is available with up to 12 circuits.

EASILY REMOVABLE CONTACTS—the stationary and movable contacts may be removed easily without disturbing the wiring.

POSITIVE MAKE OR BREAK—design of contact mechanism assures positive make or break.

For more information on any of these control products write Section 784-4, General Electric Co., 1 River Rd., Schenectady 5, N. Y.

GENERAL ELECTRIC

The basic skills and abilities of the Eichleay engineers have assured responsible installations for industries producing divergent commodities in widely separated communities. Its versatility has enabled the Eichleay Corporation to install a paper mill at Calhoun, Tennessee; a steel mill at Pittsburgh, Pennsylvania; a brass mill at Kenosha, Wisconsin; an aluminum mill at Vancouver, Washington; and a generator at Philadelphia, Pennsylvania. Eichleay's versatility has become a byword among industries desiring an economical, expeditious and orderly equipment installation.

Write for Illustrated Booklet

Eichleay

ESTABLISHED 1875

CORPORATION

33 S. 19th St., Pittsburgh 3, Pa.
1180 Richard Ave., Santa Clara, Calif.

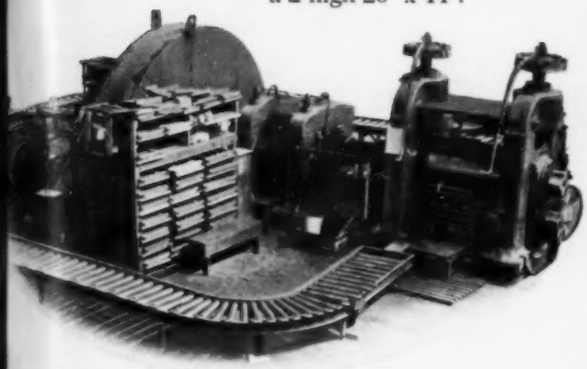
Eichleay Services

Industrial Installations
Construction of Heavy Foundations
Building and Machinery Moving
Shoring — Rigging

Number Three of a Series of Advertisements

BEFORE

Falco's #5 mill, as it looked before modernization. It is a 2-high 20" x 44".



AT FAIRMONT ALUMINUM

Same mills... big differences

Without running any faster, this line of cold mills has 20% greater capacity, thanks to BLISS modernization

RESULTS

Here's what Fairmont Aluminum reports about its Bliss-modernized mills:

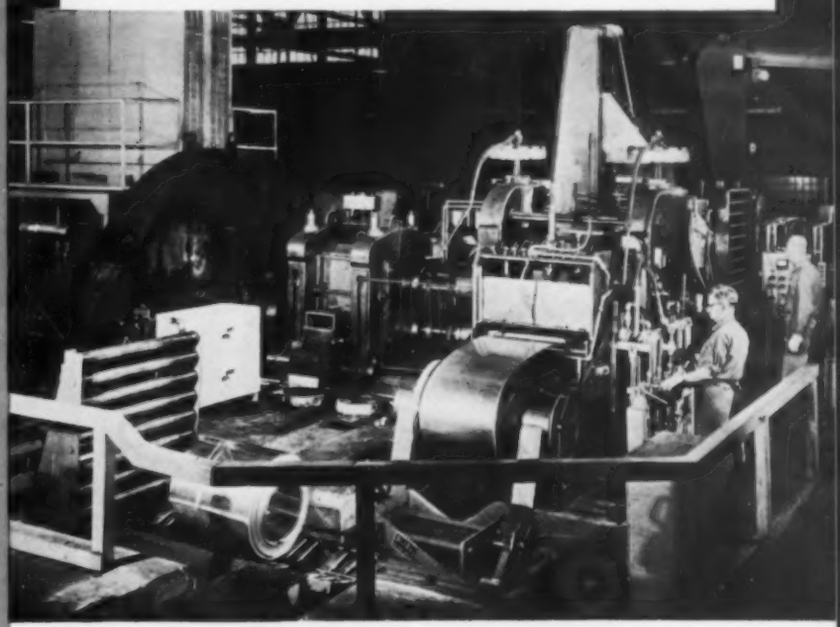
- Output is up 20% and will go higher as the plant completes other installations, such as new annealing facilities.

- Coil handling is far easier. Surface damage to the strip has been eliminated. And finish has been improved by the new roll-coolant systems ... Fairmont Aluminum formerly dry rolled.

- Thanks to the new Bliss tension reels, reduction per pass on each mill has been increased 12% or more. Former maximum was 20%.

AFTER

The same mill, as it looks today. The entry and delivery equipment has been replaced with Bliss cone-type payoff reel, tension reel, bridle unit, belt wrapper, coil buggies and upenders. The strip is accurately centered in the work rolls, and it is a simple matter to hold gage, always a problem with the old equipment. This mill is used for secondary breakdown, rolling strip in thicknesses between 0.125" and .025" and in widths to 38". Similar Bliss equipment was also added to Mill #6, used for secondary breakdown and finishing of narrower strip. Another improvement involves new motorized screwdowns presently being manufactured by Bliss.



Mill #7 is a 16" x 30" used for finishing to gages as thin as .006". It has a Bliss mandrel-type payoff (shown here), bridle feed, tension reel and roll-coolant system.

New 28" Bliss slitting line takes up to 12 cuts in 0.020" material at speeds up to 600 fpm. Bliss also revamped the plant's 36" slitting line, equipping it with tension reel, mandrel-type payoff and coil buggy.

If you are contemplating improvements or modernization, it will pay you to consult Bliss Rolling Mill Division engineers. For details of typical Bliss installations, write today for a copy of the 60-page Bliss Rolling Mill Brochure, Catalog 40-A. It's yours for the asking.

BLISS
SINCE 1857 ®

is more than a name...
it's a guarantee

E. W. BLISS COMPANY
General Office: Canton, Ohio
ROLLING MILL DIVISION, Salem, Ohio

PLANTS: Canton, Cleveland, Salem and Toledo, Ohio; Detroit and Hastings, Michigan; Pittsburgh and Midland, Pennsylvania; San Jose, California. *In Europe:* E. W. Bliss (England) Ltd., Derby; E. W. Bliss Co., (Paris), France.

Recommended for SERVICE AREA LIGHTING

HOLOPHANE REFLECTORS

with MERCURY LAMPS

At the I. and S. EXPOSITION
BOOTH 7, EXHIBITION HALL

NEW!
For the Best Lighting of Plant Low-Bay Areas

Holophane Unit 635-AL

- ***Deep-Shielded Glareless Illumination***
- ***High Output from Long Life Sources***
- ***Low Operating and Maintenance Costs***

Photos Shown: (Above) Wolverine Tube Division of Calumet & Hecla, Inc.; (Below) Kaiser Aluminum and Chemical Co.

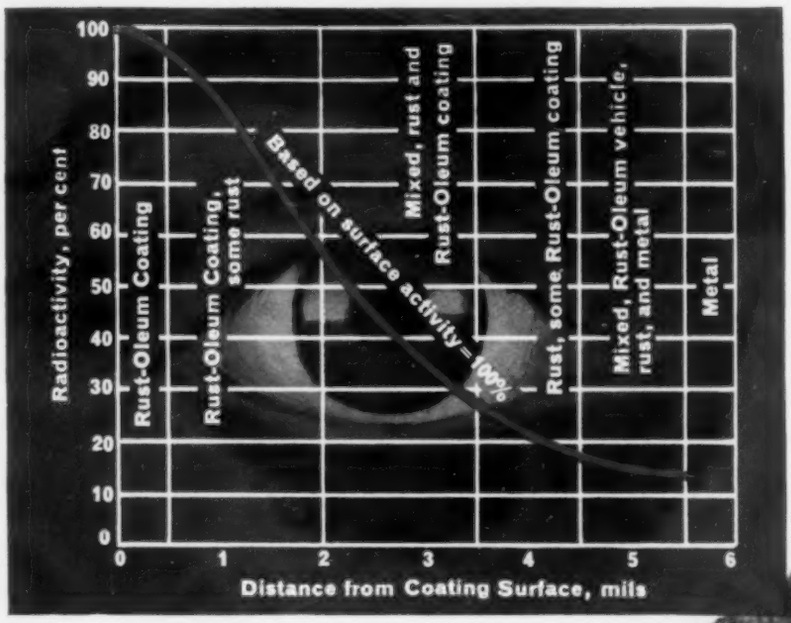
For Better Lighting Holophane *Be Specific*

Holophane research has perfected an entirely new and practical approach for illuminating industrial interiors with low mounting heights. The new unit, 635-AL, designed for mercury vapor lamps has proved highly efficient in a wide range of low bay applications. In some of these, the ceiling is as low as 12 feet above the floor, 9 feet above the work plane . . . The unit consists of a metal-covered prismatic glass reflector assembly and ventilated socket housing. Its outstanding features are deep shielding and high outputs in useful lumen zones. The open bottom assures easy maintenance and simple lamp replacement . . . Write for complete engineering data; no obligation.

HOLOPHANE

HOLOPHANE COMPANY, INC.
Lighting Authorities Since 1898
342 Madison Ave., New York 17, N.Y.
THE HOLOPHANE CO., LTD., THE QUEENSWAY, TORONTO 14, ONTARIO

See Rust-Oleum *penetrate rust* to bare metal through the "Eyes" of Radioactivity!



Curved line illustrates Rust-Oleum penetration through rust at each mil level as recorded by Geiger Counter.

Rust-Oleum dries to a firm, decorative coating that resists salt water, sun, fumes, heat, humidity, and weathering.

Geiger Counter traces Rust-Oleum penetration to bare metal! In nearly three years of radioactive research, Rust-Oleum's *specially-processed* fish oil vehicle was radio-activated and formulated into Rust-Oleum 769 Damp-Proof Red Primer – then applied to rusted test panels. Rust-Oleum's specially-processed fish oil vehicle was then traced through the rust to bare metal by Geiger Counter.

This penetration means rust-stopping power, because the fish oil vehicle works its way into the tiny pits in the metal where it drives out air and moisture that cause rust. Important savings are yours, because Rust-Oleum can be applied directly over sound rusted surfaces – usually eliminating costly surface preparations. Attach coupon to your business letterhead for your copy of the thirty-page report entitled, "The Development of a Method To Determine The Degree of Penetration of a Rust-Oleum Fish-Oil-Based Coating Into Rust On Steel Specimens," prepared by Battelle Memorial Institute technologists. Prompt delivery of Rust-Oleum is assured from your nearby industrial distributor.

There is only one Rust-Oleum. It is distinctive as your own fingerprint.

RUST-OLEUM®

STOPS RUST!

Rust-Oleum is available in practically all colors, including aluminum and white. See our complete catalog in Sweets, or write for information.

ATTACH TO YOUR LETTERHEAD—MAIL TODAY!

Rust-Oleum Corporation
2441 Oakton Street
Evanston, Ill.

- ☐ Complete literature with color charts.
- ☐ Thirty-page report on Rust-Oleum penetration.
- ☐ Nearest source of supply.

Johns-Manville organizes to give you better insulation service

New and separate insulations division created to provide industry greatly improved Sales and Engineering service to meet modern problems

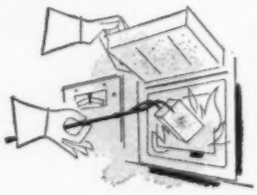
• Johns-Manville is now concentrating all industrial insulation operations within a new, fully integrated insulations division. This greater specialization makes possible the most complete insulation service available to industry. It consists of—

Sales Representatives . . . men on whom you can rely for your insulation recommendations. Your J-M salesman will help you select the insulating material exactly right for your job—the one that will provide maximum fuel savings, improved process control, and minimum maintenance. As co-ordinator of J-M's extensive research-engineering-manufacturing facilities, he offers you outstanding insulation training and experience.

Insulation Engineers—Backing up the J-M salesman on every job is the J-M insulation engineer. He is primarily concerned with solving insulation problems. He recommends the economic thickness of insulation, as well as the proper finishes, weatherproofing and securement. His highly specialized knowledge makes possible an intelligent recognition and handling of your individual insulation requirements.

Insulation Contract Units . . . Fully aware that no insulation is better than the man who applies it, the J-M Insulation Contractor makes care and skill in the scientific application of Johns-Manville insulations his stock in trade. He maintains a complete crew of estimators and mechanics trained in J-M application techniques. He is ready to give you fast, efficient service on any insulation job—large or small. Proud of his reputation for integrity in his own community, the J-M Insulation Contractor merits your complete confidence.

Complete Range of Products—In this day of exacting temperature control, the need for specific insulations for specific services is greater than ever before. Recognizing this, Johns-Manville manufactures insulations for every industrial requirement. Produced from the finest grades of asbestos, magnesium carbonate, diatomaceous silica, refractory clays and ceramic fibers, they are designed to afford maximum insulating effectiveness and durability at operating temperatures ranging from minus 300F to plus 3000F.



Extensive Research Facilities—At Manville, New Jersey, Johns-Manville maintains the world's most completely equipped insulation laboratory. Here insulation scientists are engaged in a continuous program of developing new and better insulating materials. In addition, their technical knowledge is always available to J-M customers whose insulation problems require special study.

Experienced Management—At headquarters as well as in the field, management of the new insulations division consists of men who, in line with J-M's promotion-from-within policy, are insulation veterans. With a realistic grasp of customers' needs, they are alert to new and better ways to serve you . . . now, and in the future.

On Your Next Insulation Job—Whether your next insulation job is big or little, simple or complex, let Johns-Manville handle it for you. Just call your nearest J-M sales office, or write direct to Johns-Manville, Box 14, New York 16, New York. In Canada, Port Credit, Ontario. *Chances are, you'll be glad you did!*

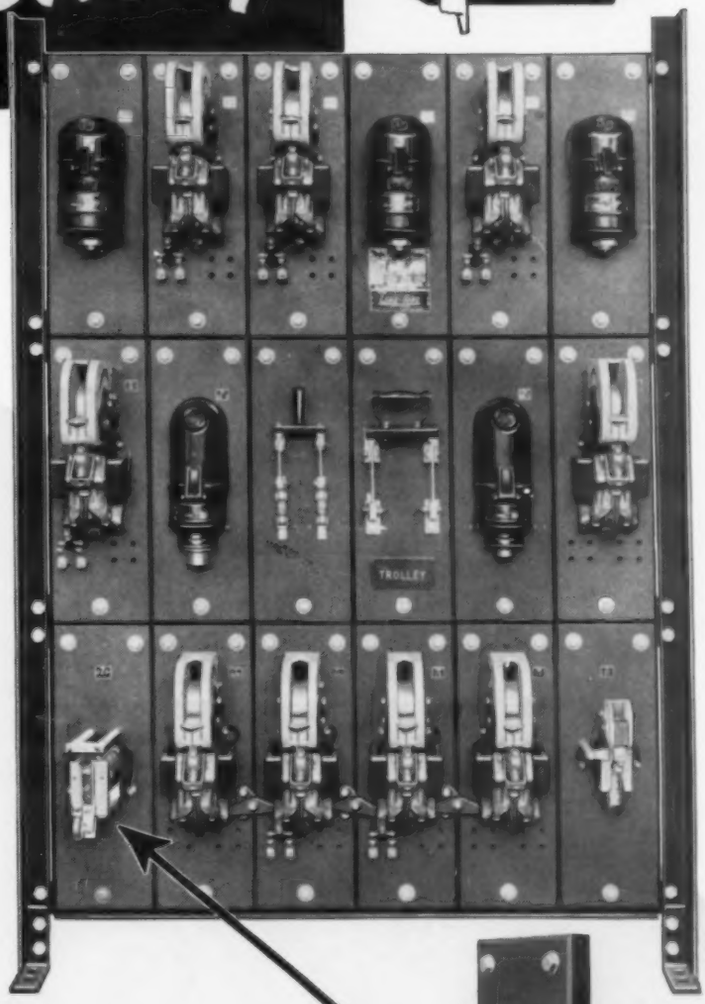
JOHNS-MANVILLE JM PRODUCTS

Johns-Manville *first-in* INSULATION

MATERIALS · ENGINEERING · APPLICATION

when stopping DC Motors

EC&M's Rectifier Plugging Control System gives FULL PROTECTION!

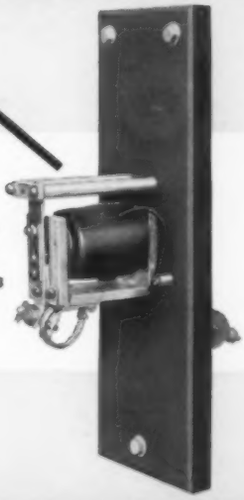


• This is the simplest of all plugging control systems for D.C. mill and crane drives. Only a small rectifier and single-coil mill-duty relay are required. They are connected across the motor armature for operation by counter-emf. The relay allows the plugging contactor to close immediately when starting from rest. When reverse-power plugging is applied to stop the motor, the rectifier permits the relay to pick up and hold open the plugging contactor. As the motor reaches stand-still, the relay drops out to close the plugging contactor and to allow acceleration in the opposite direction.

TWO-STEP PLUGGING CONTROLLERS are available for use on heavy inertia loads such as ore bridge trolleys and ladle crane bridge motions. Ask an EC&M Engineer to explain the improved operation of D.C. motors by Rectifier Plugging.

HERE'S WHY EC&M GIVES MOTOR DRIVES BETTER PROTECTION

- ✔ **POSITIVE RESPONSE** • Relay operates directly from counter-emf of motor.
- ✔ **RELIABLE OPERATION** • Unaffected by line voltage variation. Unaltered if taps on accelerating or plugging resistors are changed.
- ✔ **FULL PROTECTION** • Relay picks up at any speed above 10% of F. L. motor speed. Drop-out occurs as motor reaches standstill.
- ✔ **SIMPLICITY** • Single-coil relay and small rectifier. No electrical interlocks.
- ✔ **LESS MAINTENANCE** • Relay does not require adjustment-maintenance.



View of Type FKP Relay used on EC&M D-C Magnetic Controllers

SQUARE D COMPANY

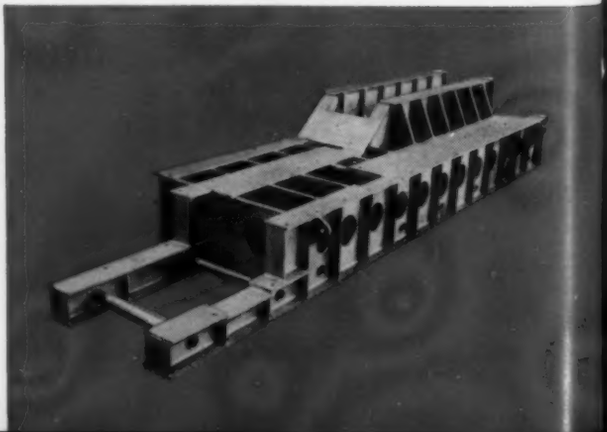
EC&M DIVISION • CLEVELAND 28, OHIO

7406

CONTINENTAL high-speed 21″x53″x60″, 4-stand tandem cold mill in the Gibraltar Plant of the McLouth Steel Corporation.

CASTINGS—carbon and alloy steel castings from 20 to 250,000 pounds.

WELDMENTS—fabricated steel plate, or cast-weld design.



BLAW-KNOX
makes what it takes
to cold roll
at high speeds

In the Gibraltar Plant of McLouth Steel, this modern CONTINENTAL 60-inch, 4-stand tandem cold mill rolls steel at delivery speeds in excess of 3,000 fpm.

Designed to meet specific customer requirements, the mill has interesting features, such as—(1) entry and delivery coil conveyors of this cold strip mill, and two single-stand skin-pass mills, are at floor level—which provides greater safety, more efficient handling and easy inspection of all coils during processing. (2) mill equipment has built-in raceways to carry the electrical cables—which simplified the installation and provides easy access for maintenance.

BLAW-KNOX designs and builds *complete* rolling mill installations—assumes undivided responsibility from preliminary engineering to satisfactory operation. At any time we'll be glad to discuss your plans with you.

BLAW-KNOX COMPANY
Foundry and Mill Machinery Division
Blaw-Knox Building • 300 Sixth Avenue
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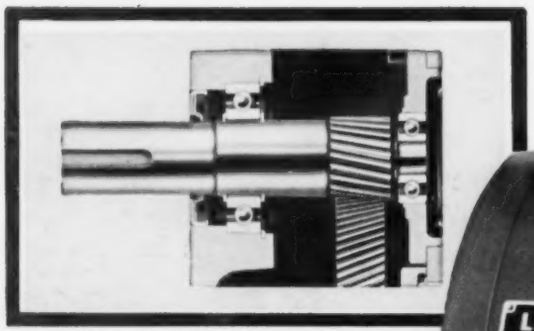

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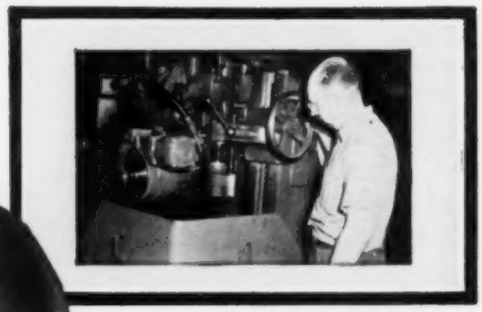

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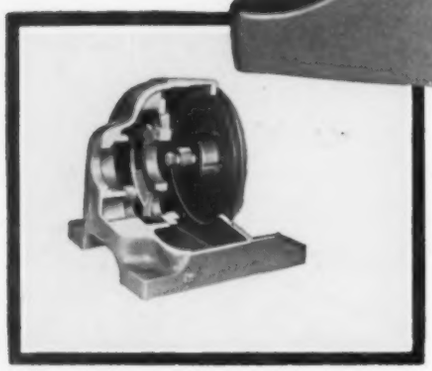

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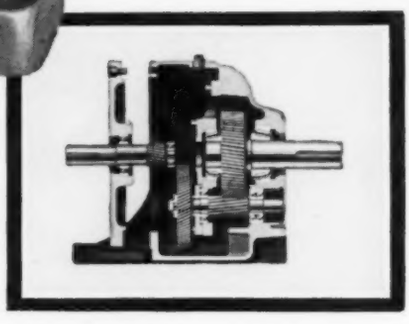

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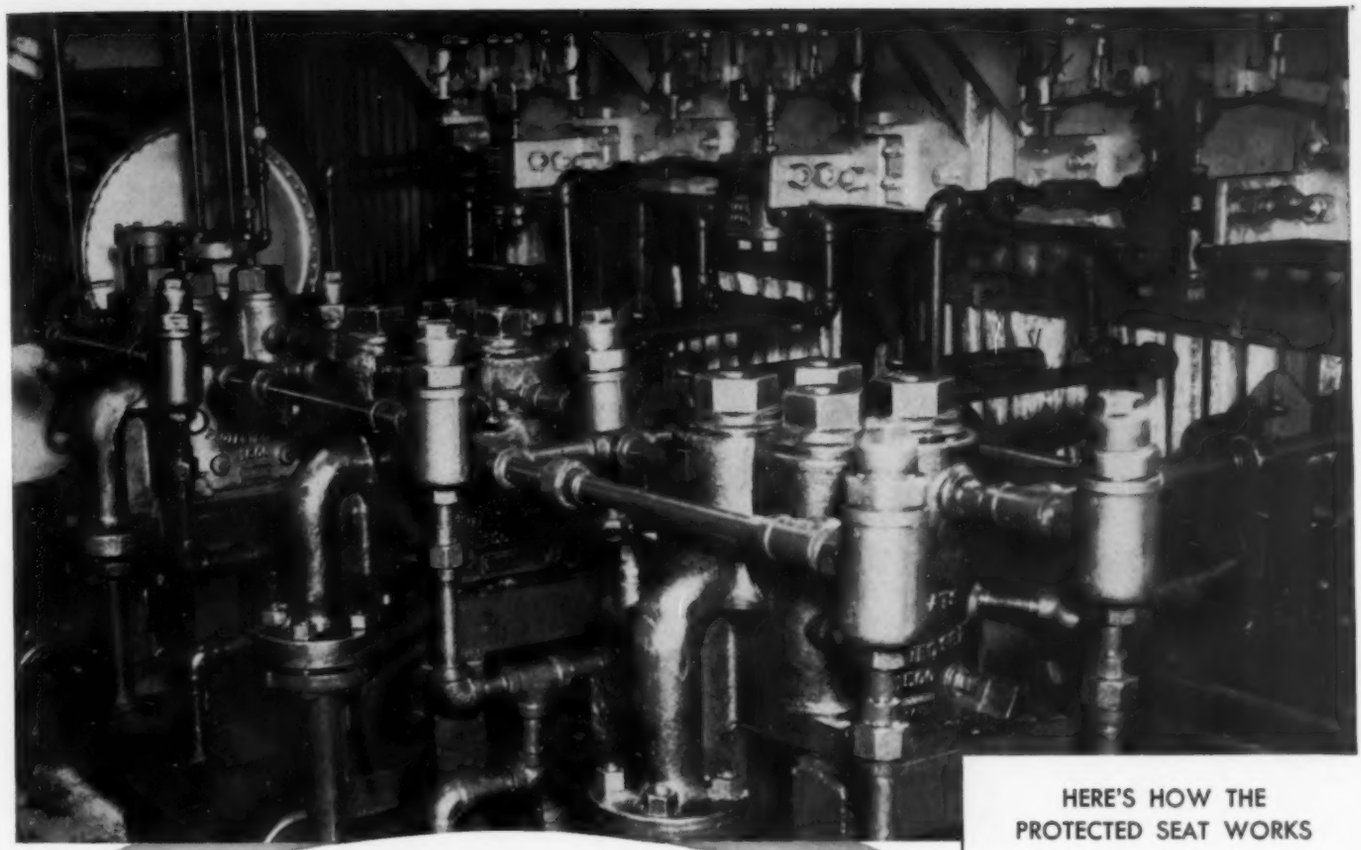

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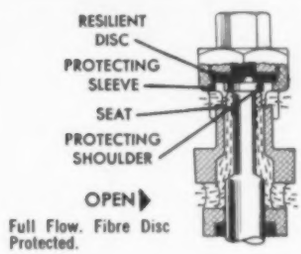

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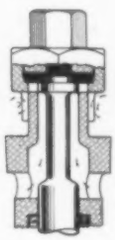

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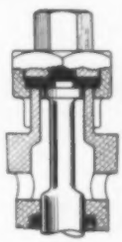

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Dravo ore bridges unload, stock and reclaim blast furnace materials at McLouth Steel

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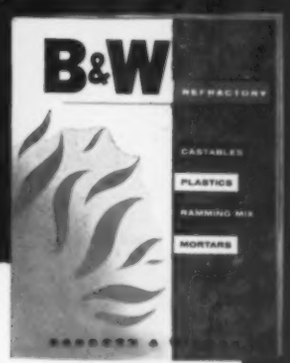

Table of Products and Uses

	Page
Castables	
B&W Kaocrete-32 — Special High Temperature Service—To 3200 F	7
B&W Kaocast — High Temperature, General Purpose Use—To 3000 F	8-9
B&W Kaocrete-A — General Purpose Use—To 2700 F	10-11
B&W Kaocrete-B — For Ease of Plastering in General Purpose Use—To 2300 F	10-11
B&W Kaocrete-D — For Extra Strength and Abrasion Resistance—To 2500 F	10-11
B&W Kromecast — Chrome-base Castable for Resistance to Attack of Slag and Other Reactive Products—To 3100 F	12
B&W Hydrochrome — Chrome-base Castable for Resistance to Attack of Slag and Other Reactive Products—To 2800 F	12
Insulating Concrete-Mixes	
B&W Kaolite-20 · Kaolite-20-Gun **B&W Kaolite-22 · Kaolite-22-Gun** — For Castable Convenience Plus Insulating Effect	13

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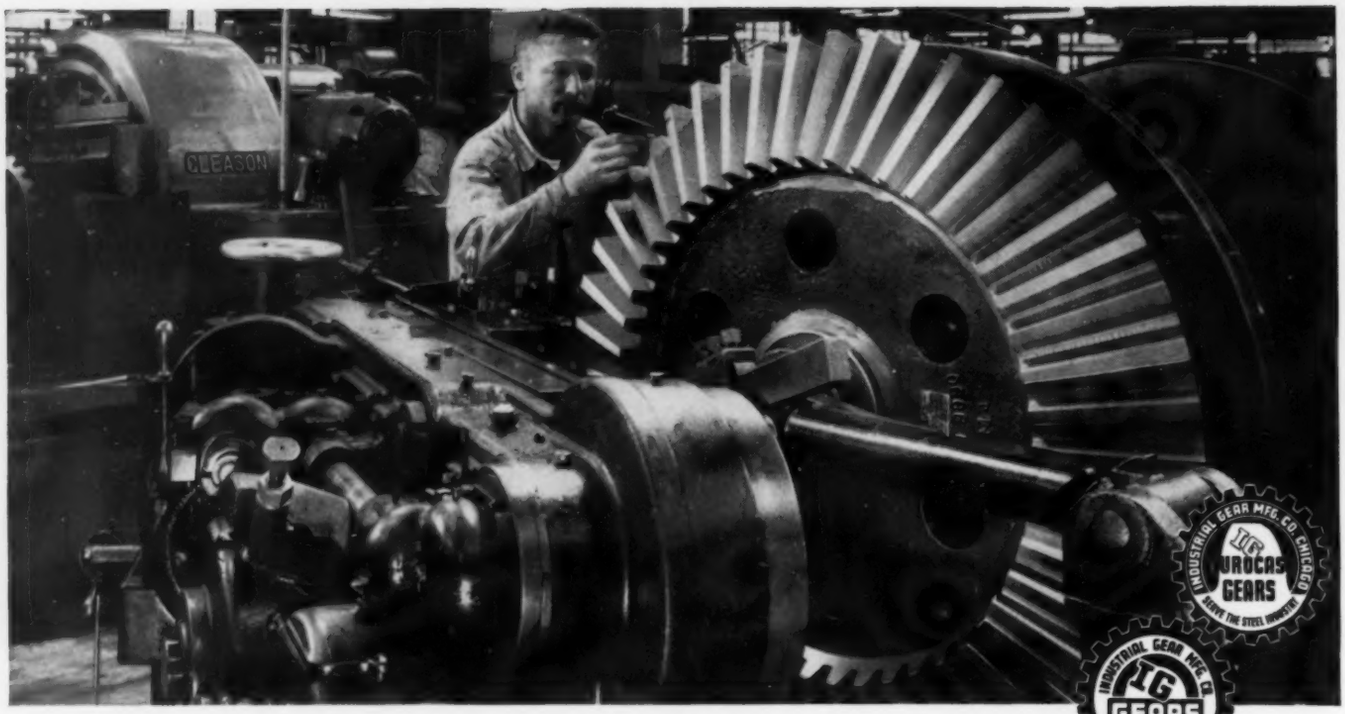

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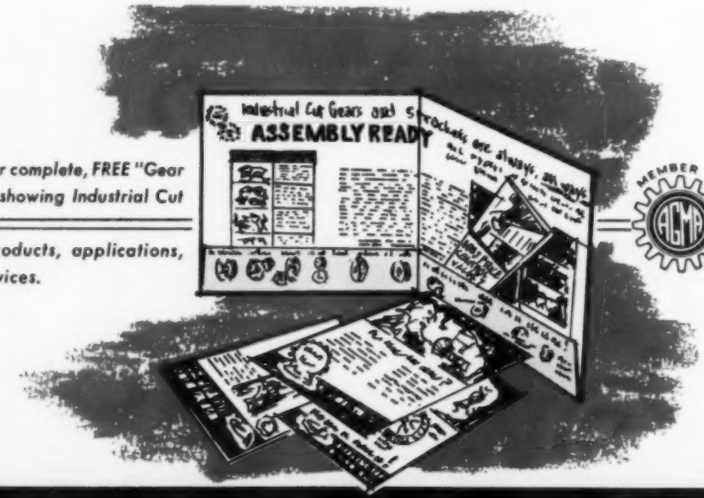

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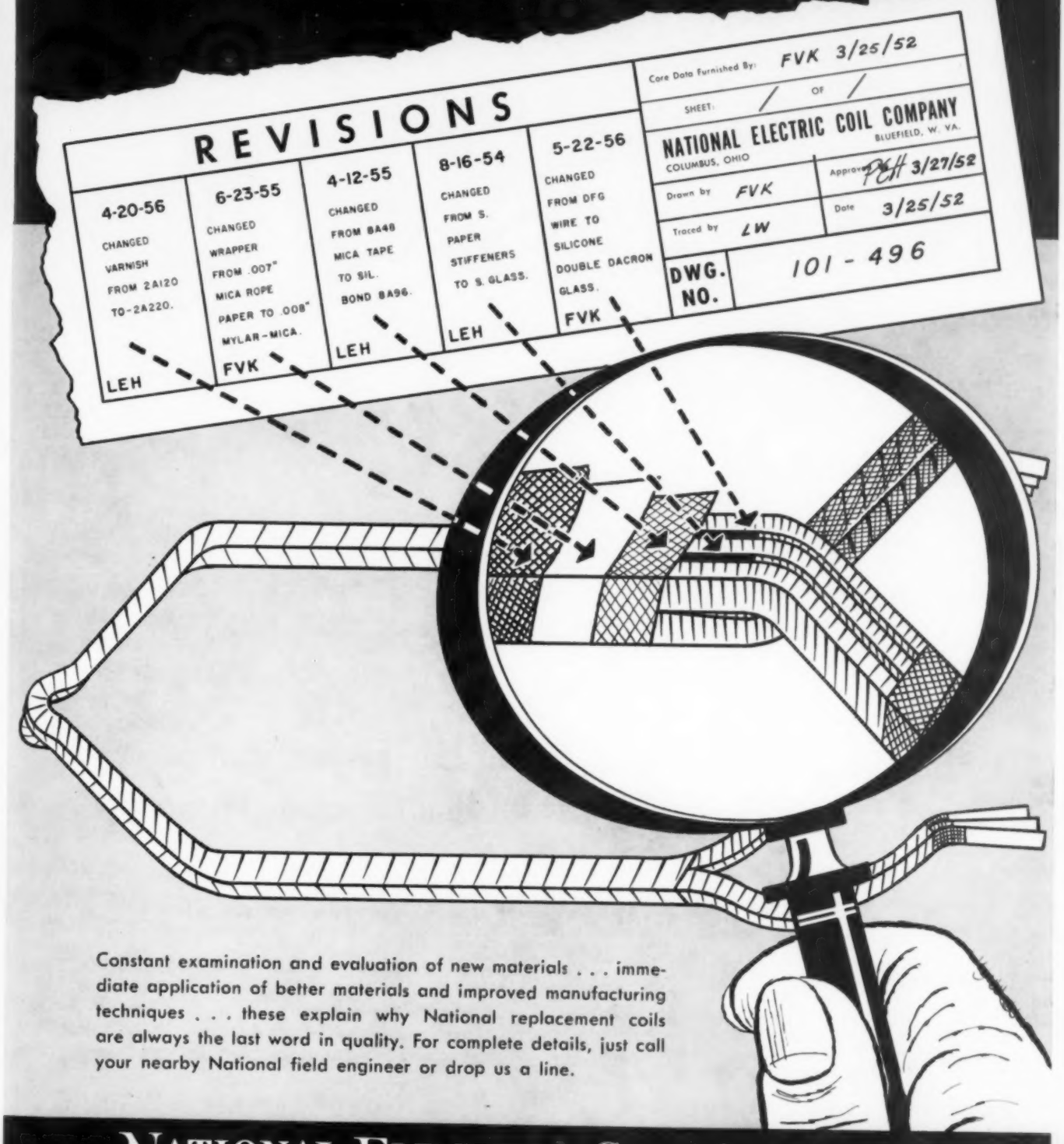

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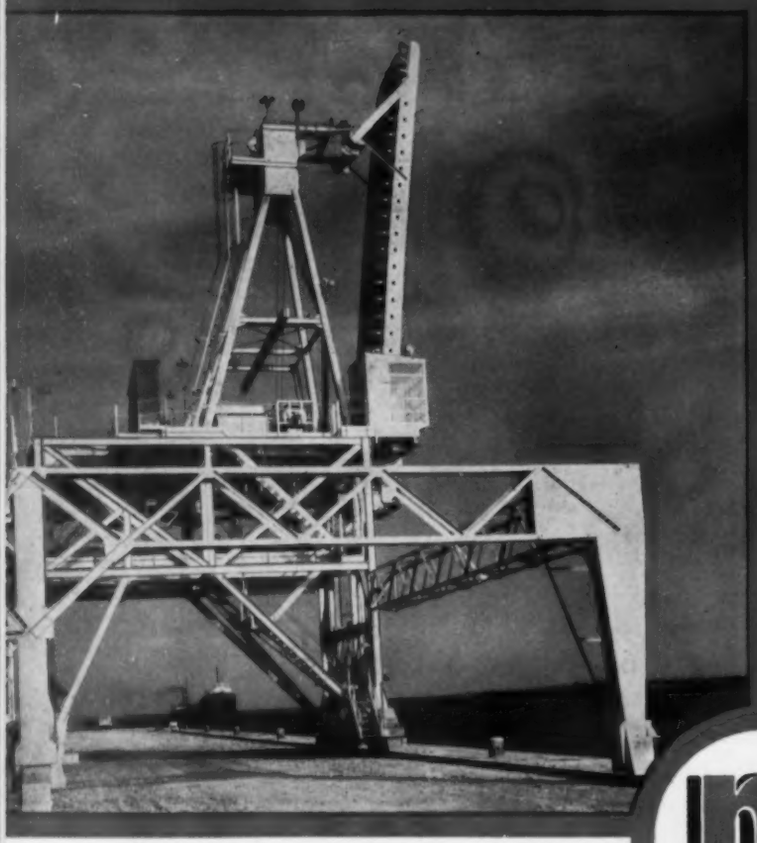

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Patent Reviews

. . . . copies of patents may be obtained from the Commissions of Patents, Washington 25, D. C., at 25 cents . . . . patents reviewed cover period April 3, 1956 through April 24, 1956 . . . .

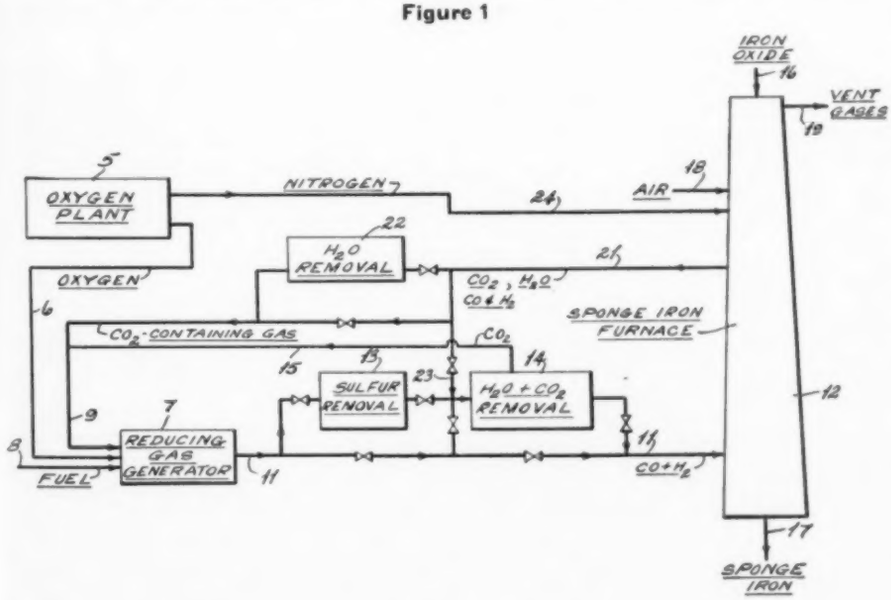
REDUCTION OF IRON OXIDE TO SPONGE IRON

▲U. S. 2,740,706, issued April 3, 1956 to Peter L. Paull and Frederick Burton Sellers, assigned to Texaco Development Corp., describes a process for reducing iron oxide to sponge iron, using gaseous, liquid, or solid fuels to generate a reducing gas consisting of hydrogen and carbon monoxide. The generation of the reducing gas is accomplished by reacting oxygen with the fuel.

As shown in Figure 1, the purified reducing gas is fed near the bottom of the stack furnace 12, countercurrent to the iron oxide. A stream of gas is removed at a higher point, 21, and after separation of CO_2 and H_2O, the CO and H_2 are recycled. The object of this operation is to provide CO_2 for use in the gas generator, thus producing a reducing gas containing more CO than H_2.

In the upper portion, air is introduced, burning the remaining CO and H_2 and preheating the incoming iron oxide to reaction temperature. Temperature control is achieved by adding nitrogen (obtained from the air separating plant used to produce oxygen) below the air inlet point.

Figure 1



GALVANIZING SHEET METAL STRIP

U. S. 2,740,729, issued April 3, 1956 to Ralph Hodil and assigned to Granite City Steel Co., describes an improvement in the process for galvanizing sheet metal strip.

When the sheet metal strip A in Figure 2 leaves the galvanizing bath 7, it passes through rolls 9 which do not rotate. These rolls are about 3½ in. in diam and are made from a hardened abrasion-resisting alloy which does not combine with zinc. Rolls of this type permit little or no zinc alloy buildup at the edges of the sheet metal strip. The use of these rolls removes the usual limitation on the speed of the sheet metal strip.

The rolls can be rotated manually or automatically, at intervals, when they become flattened.

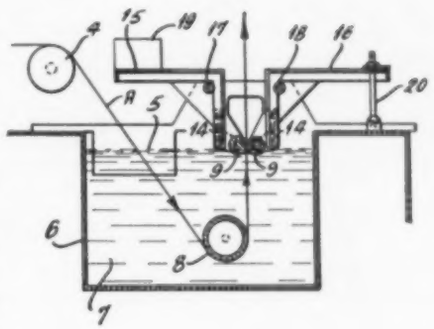


Figure 2

PROCESS FOR PICKLING STEEL

U. S. 2,741,250, issued April 10, 1956 to Cornelius A. Rauh, describes a process for the continuous pickling of steel, in which the pickling medium is continually reconditioned.

As shown in Figure 3, pickling tanks 1, 2, 3 are continually supplied from manifold 6 with reconditioned pickle liquor flowing from a heater 8. Used pickle liquor is siphoned from each tank, most of it being recirculated to heater 8, but part of it dropping to a storage tank 21.

Pickling solution from storage tank 21 is pumped to evaporator 30, where it is heated to 240 F by submerged combustion burner 38. Flue gas and evaporated water pass to the primary heater 8, where they pass up through a suitable packing countercurrent to the cooler recirculating solution. Water vapor is condensed by the acid solution, thereby allowing recovery of the latent heat of evaporation.

The cooled gas stream is carried up to a packed chamber 46 and then to a secondary heater 34. Strong acid from a crystallizer 31 is fed through inlet 47 to the packed chamber 46, absorbing more water vapor

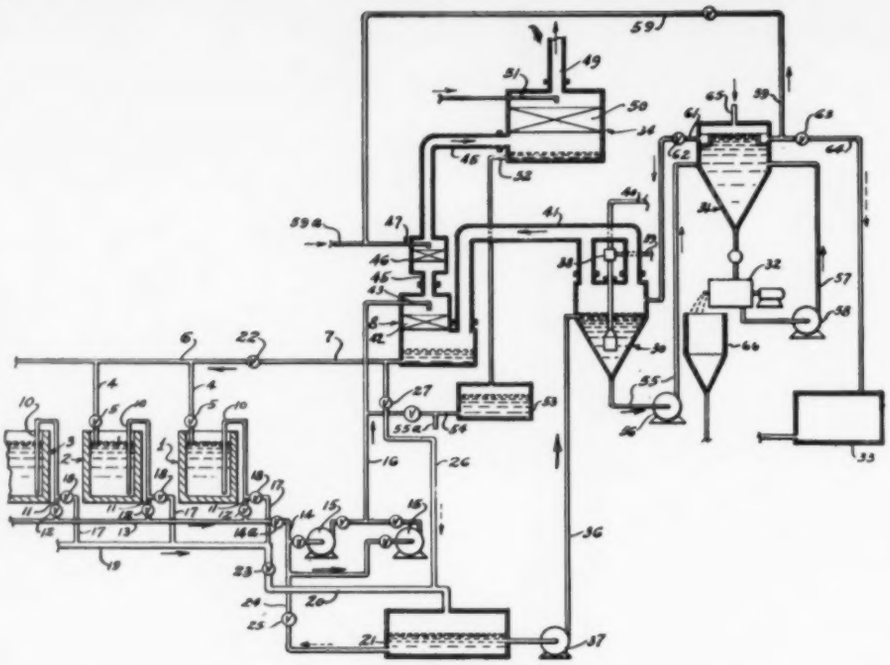


Figure 3

and heat, and dropping into the primary heater 8.

In the secondary heater 34, the partially cooled flue gas is further cooled before being vented to the atmosphere through outlet 49. Water passes down through the secondary heater 34. The heated water which results drops to a hot water storage tank 53. Part of this hot water is fed as make-up water to heater 8. The rest is used in rinsing pickled steel. Make-up acid is fed at 59a and 65.

From the bottom of the evaporator 30, concentrated pickling solution, with fine ferrous sulphate monohydrate crystals thrown down by the concentration, is continually pumped to crystallizer 31, where further crystallization and the growth of ferrous sulphate monohydrate occurs. Clear concentrated acid overflows from the crystallizer to the evaporator 30, providing rapid recirculation in the vicinity of the burner.

Crystals are withdrawn from the bottom of the crystallizer to a centrifuge 32, the salt going to a storage bin 66, and the mother liquor being returned to the crystallizer. Strong acid also overflows from the crystallizer back to the packed chamber.

OXYGEN CONVERTERS

U. S. 2,741,554, issued April 10, 1956 to Rudolf Franz Rinesch, describes a method of refining pig iron in an oxygen converter.

As shown in Figure 4, the converter 10 includes an outer shell 11 formed of steel plate, with a permanent lining of magnesite brick 12 coated with a dolomite-tar mix which forms a ram coat 13 and bottom lining 14. An inner lining of dolomite-tar bricks 15 forms the wear-resistant lining of the converter. This lining has the advantage of showing the amount of wear on the linings when the converter should be taken out of service. The lining lasts for 7 to 10 days (200 to 250 blows).

The converter is mounted for tilting for charging and discharging.

In order to remove phosphorus, the slag temperature should be maintained below that of the molten metal. This can be accomplished by adding limestone or cold slag when the slag becomes too hot. Thus, the refining operation can be completed in 15 to 30 minutes.

The oxygen enters through a lance 20 having a copper nozzle on top and having a water-cooled jacket to prevent damage to the nozzle. The diam of the nozzle is 1.1 to 1.4 in. for a 30-ton converter. Oxygen is supplied at 4 to 12 atmospheres in the amount of 4000 to 8000 cu meters per hr. The amount of scrap added is based on the silicon and phosphorus content of the pig iron.

Control over the carbon end point is obtained by reducing the oxygen pressure near the end of the blowing time.

The phosphorus content of the steel can be reduced to 0.005 to 0.04 per cent, starting with a pig iron containing as much as 0.175 per cent phosphorus. About half the sulphur is also removed. The nitrogen content of the steel is very low, usually about 0.003 per cent.

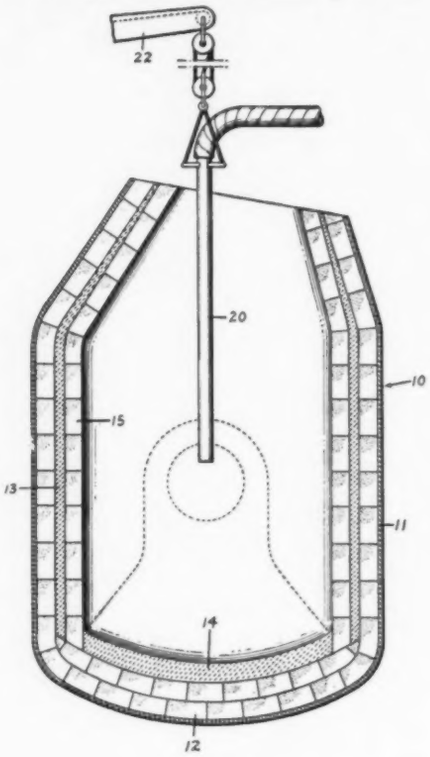
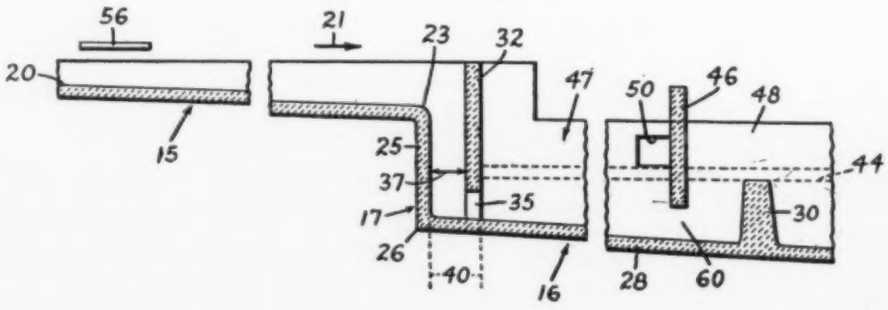


Figure 4

In a second patent relating to oxygen converters, U. S. 2,741,555, issued April 10, 1956 to Otwin Cuscoleca et al, and assigned to Oesterreichisch-Alpine Montangesellschaft, details

Figure 5



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the location of the lance with respect to the molten metal surface and the range of allowable impact pressures of the oxygen blast are disclosed.

DESULPHURIZATION OF IRON

U. S. 2,741,556, issued April 10, 1956 to Harry J. Schwartz and assigned to Allied Chemicals Dye Corp., describes a procedure for desulphurizing molten iron with soda ash in a runner operation.

In Figure 5, soda ash is dropped from a feeder 56 over the width of the runner section 15, forming a floating layer on the molten metal. Gas evolution from the soda ash takes place steadily in this section, without foaming. After complete degasification and melting of the soda ash, violent mixing of the molten iron and the resulting caustic soda layer is accomplished in and around orifice 35. The velocity is then reduced in downstream section 16, which is wide and deep. Skimmed metal from upstream of dam 46 flows through orifice 60 and over dam 30, the slag having already been skimmed off. The slag-free iron overflowing dam 330 has had about 60 per cent of its sulphur removed.

APPARATUS FOR POURING INGOTS

U. S. 2,741,814, issued April 17, 1956 to George Ross Hazlett, describes a method of pouring ingots which are free of piping, but which requires no hop tops.

As shown in Figures 6 and 7, a special elliptical pouring ladle 6 is mounted over an elliptical mold 1. The stream of metal 4 flows through the pouring ladle 6, out through openings 10 at the bottom, and into the ingot mold 1 without splashing. As the metal rises in the mold, the pouring ladle is gradually raised. According to the inventor, piping is normally caused to a large degree by the swirling action of the metal rising in the ingot mold caused by center pouring, and the present invention avoids this.

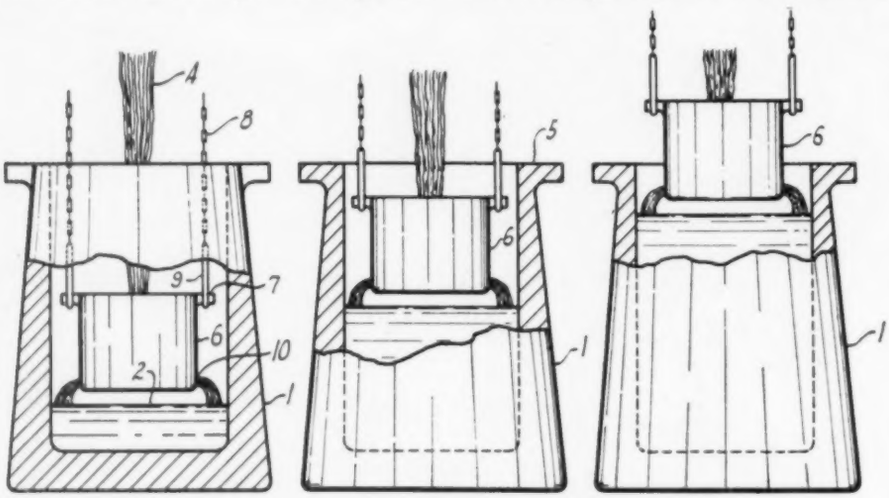


Figure 6

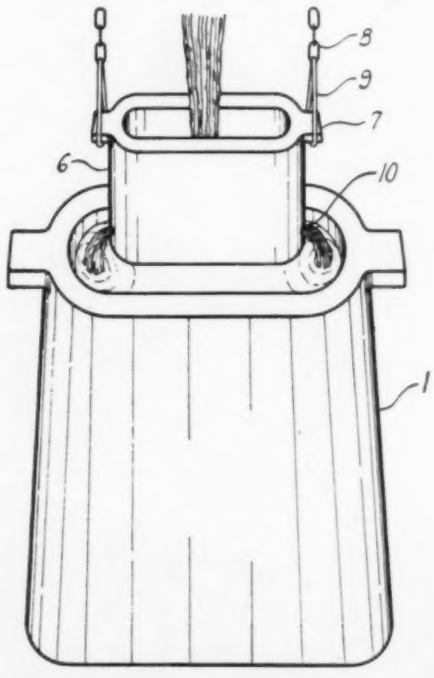
PRODUCTION OF SPONGE IRON

U. S. 2,742,352, issued April 17, 1956 to Edwin R. Gilliland and assigned to Esso Research and Engineering Co., describes a process for the reduction of iron oxide ore to sponge iron with gaseous hydrocarbons such as natural gas. The ore in a finely divided state is suspended by upflowing gases. At the bottom of the apparatus, gas is admitted, causing reduction of the ore before the latter leaves at the bottom. As the gases flow upward, they are mixed with air and burned, thereby heating the incoming ore to reaction temperature.

In U. S. 2,742,353 issued April 17, 1956 to Henry J. Orgorzaly and assigned to Esso Research and Engineering Co., the finely divided ore is reduced in a fluidized bed reactor with CO formed in the reactor from coke and preheated air.

In U. S. 2,742,354, issued April 17, 1956 to Henry J. Orgorzaly and assigned to Esso Research and Engineering Co., CO is produced by high temperature gasification of a carbonaceous material in one fluidized bed, and the reduction of iron ore takes place in another fluidized bed.

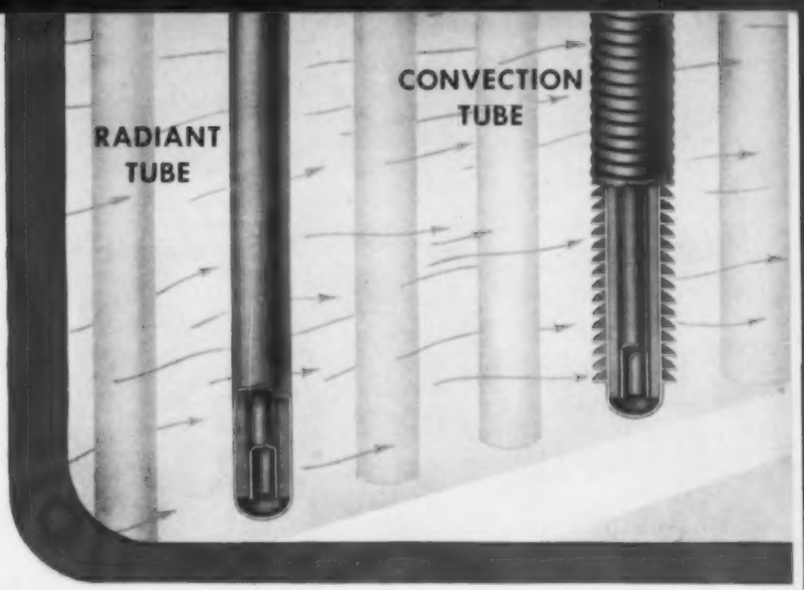
Figure 7



PATENT REVIEWS FOR IRON AND STEEL ENGINEER

Patent No.	Date	Subject	Inventor or Assignee
2,740,521	4/ 3/56	Apparatus for gaging sheets	United States Steel Corp.
2,740,710	4/ 3/56	Reduction of oxidic ores containing nickel, cobalt, chromium and manganese	Fredrich Johannsen
2,740,711	4/ 3/56	Iron-chromium-molybdenum-titanium base alloy	Allegheny Ludlum Steel Corp.
2,741,585	4/10/56	Marking strip in an electrotinning line	United States Steel Corp.
2,741,816	4/17/56	Wiper ring mountings for hot tops	Herbert A. White, Jr.
2,742,002	4/17/56	Soaking pit cover	George P. Reintjes
2,742,019	4/17/56	Metal coating apparatus	Inland Steel Co.
2,742,150	4/17/56	Apparatus for gaging and classifying sheets	United States Steel Corp.
2,742,269	4/17/56	Recuperator	Rekuperator K. G. Dr. Ing. Shack & Co.
2,742,691	4/24/56	Method of making corrosion resistant clad steel	Commonwealth Engineering Co. of Ohio
2,743,172	4/24/50	Preparing indurated pellets of iron ore fines	Erie Mining Co.
2,743,203	4/24/56	Phosphate coating for electrical steel	Westinghouse Electric Corp.

Retube with BROWN "Refrigerated" RECUPERATOR TUBES



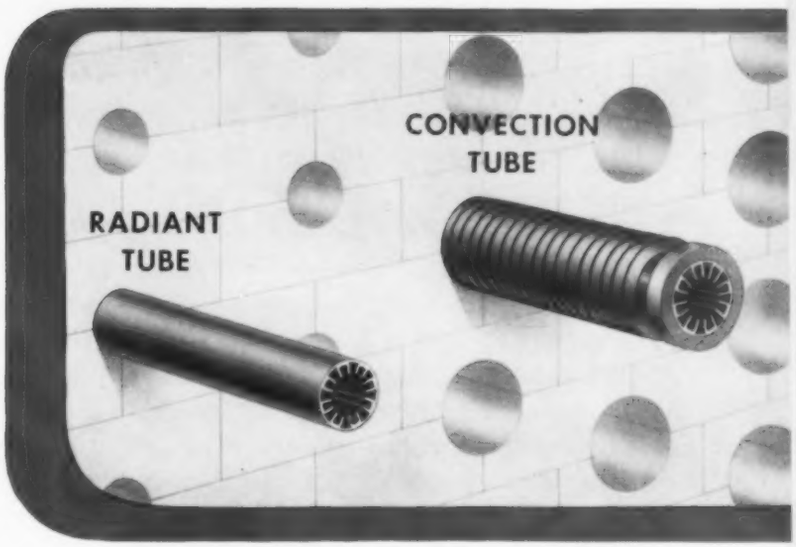
Now available in any length — any O.D.— any I.D., and any wall thickness for vertical "bayonet" type applications. Finned on the inside only for the radiant zone. Finned on both the inside and outside for the convection zone. Designed to last longer while attaining a higher preheat. Get the full story today!

BROWN FINTUBE COMPANY

HOME OFFICE *Elyria, Ohio,* P. O. BOX 520

Integrally Welded Fintubes and Fintube Heat Transfer Products

Retube with BROWN "Refrigerated" RECUPERATOR TUBES



For horizontal once through recuperator designs. Finned on the inside only for the radiant zone. Finned on both the inside and outside for the convection zone. Wide range of sizes fit any existing recuperator. Retube with Brown "Refrigerated" Fintubes once. Your results will prove their great merit.

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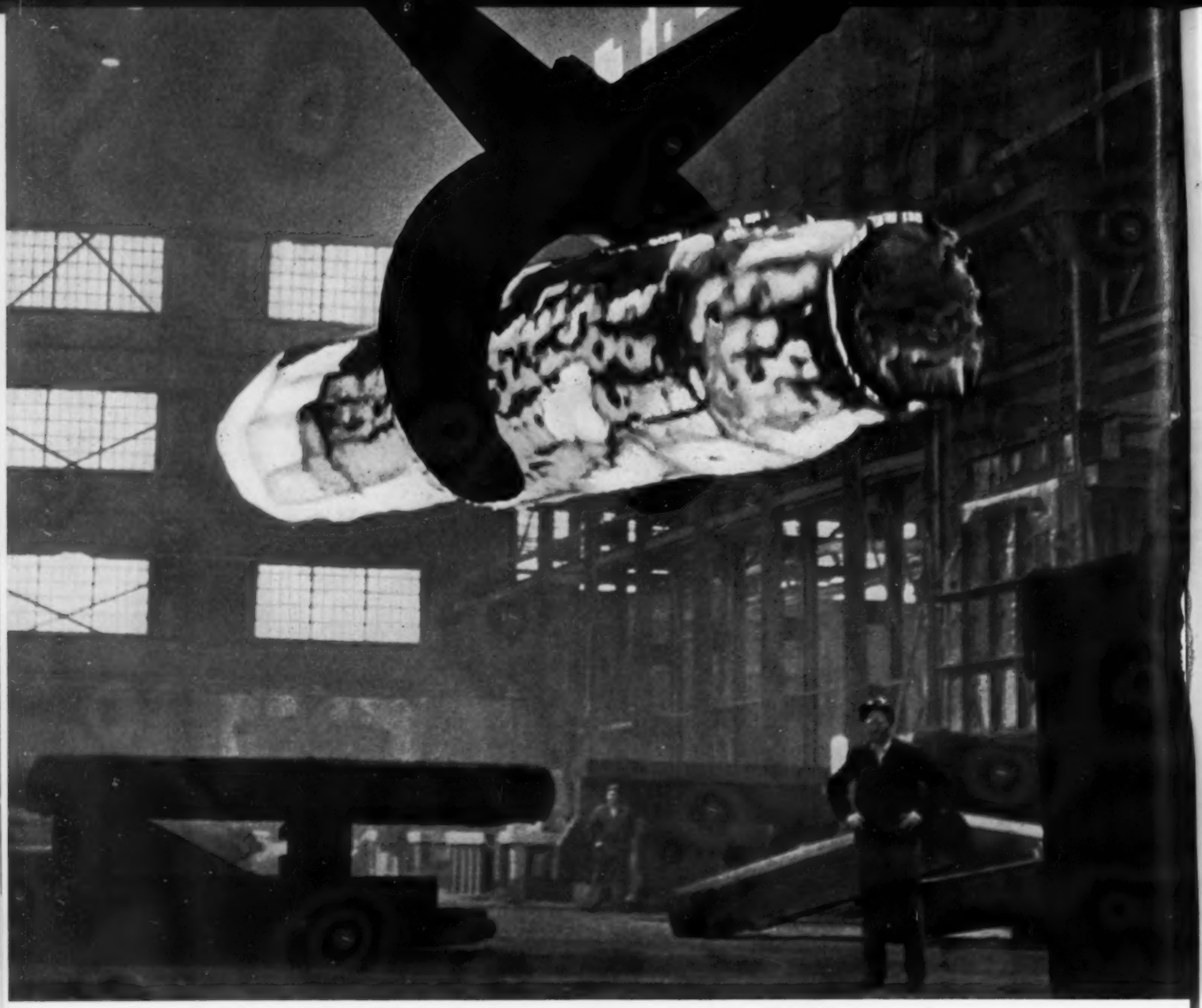
Integrally Welded Fintubes and Fintube Heat Transfer Products



Another Big One on the Way

This glowing mass of steel winging through the air is a large forged roll in the making. As you see it here, it has been blocked and reheated, and is now en route to the second forging operation. When the Bethlehem shops have finished with it, the roll will have a maximum diameter of 36 in. and a length of 10 ft. It will weigh 21 tons after finish-machining and grinding. The customer plans to use it for hot-rolling aluminum.

Rolls like this require the most painstaking care in every detail of manufacture. At Bethlehem they get it. Steel-making, forging, heat-treating and machining are all in expert hands, and the strictest metallurgical controls are enforced throughout. When a Bethlehem roll emerges from the shops, it meets all specifications on size, finish, hardness. It's ready for action.

Whatever your needs in rolls, we can meet them to your entire satisfaction. Call us if your operations involve cold-rolling ferrous sheets and strip . . . running-down and finishing steps on copper and brass sheets . . . hot- and cold-rolling aluminum sheets . . . cold-rolling aluminum foil.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

One of the most modern bridges...

EVER BUILT!

H & P Man Trolley with adjustable Voltage Control operating off AC Power Supply.

HEYL & PATTERSON 20 TON CAPACITY BRIDGE

Half-a-century of performance records prove that Heyl & Patterson Ore and Coal Bridges are designed, built and erected for dependable and long-lasting performance. Bridges similar to the one shown here for stocking and reclaiming ore, are designed in cooperation with the engineers of many Steel Companies, to function economically and safely with an important object in mind . . . reduction of structural, mechanical and electrical maintenance.

TAKE A GOOD LOOK AT THIS BRIDGE. Then ask a Heyl & Patterson Sales-Engineer to demonstrate how its many features can reduce to a minimum the cost of your operating budget.

H & P FEATURES WORTHY OF YOUR CONSIDERATION . . . Wide Flange Beam Construction to reduce rust corrosion . . . Adjustable Voltage Control for smooth trolley operation, for increased hoisting speed and reduction of trolley weight . . . Aluminum Contact Conductors . . . Fabreeka Mountings for shock absorption . . . Worm Gear Driven Trucks . . . Hydraulically Operated Automatic Rail Clamps . . . Trolley Buffers. These are some of the features justifying the headline . . . "One of the Most Modern Bridges Ever Built."

Heyl & Patterson
INC.

VISIT H&P AT THE IRON & STEEL EXPOSITION BOOTHS 242 AND 243

55 FORT PITT BLVD. • PITTSBURGH 22, PA. • Phone COurt 1-0750

HAGAN CONTROL helps

Flexibility of Hagan control system permits solution of ingot heating problem at Crucible Steel's Midland Plant.

Faced with the need for better circulation at low fuel input, Crucible's engineers adjusted the Hagan Fuel-Air regulator so that it was biased to produce automatically an accurately measured dilution of the gas-air mixture at low flows (from 106% theoretical air during the heating period to 215% theoretical air during the soaking period). No scale problem was encountered.

This gave the effect of firing a low Btu gas and achieved the desired uniformity of heat distribution. Tons per hour increased, and Btu's per ton decreased.

The engineers were very satisfied with the results achieved by this change, and made the comment, "We were fortunate in having a control flexible enough to do this."

Hagan control components are built with this particular objective in mind. Every unit is designed to offer engineers wide latitude not only in application, but also in performance. Hagan instruments and controls are dependable, extremely accurate and versatile. Why not discuss your control and instrumentation problems with the Hagan engineer. He can help you find a solution.

solve a soaking pit problem

NOTES ON THE HAGAN INSTALLATION AT CRUCIBLE STEEL'S MIDLAND PLANT.

Fuel-Air Ratio Control

A high degree of accuracy is achieved in this part of the Hagan soaking pit control. In normal operation, a double diaphragm regulator controls the ratio by pneumatically repositioning the combustion air valve. This normal operation can be varied by moving the fulcrum of the ratio regulator. This is provided by:

Combustion Air Temperature Compensation

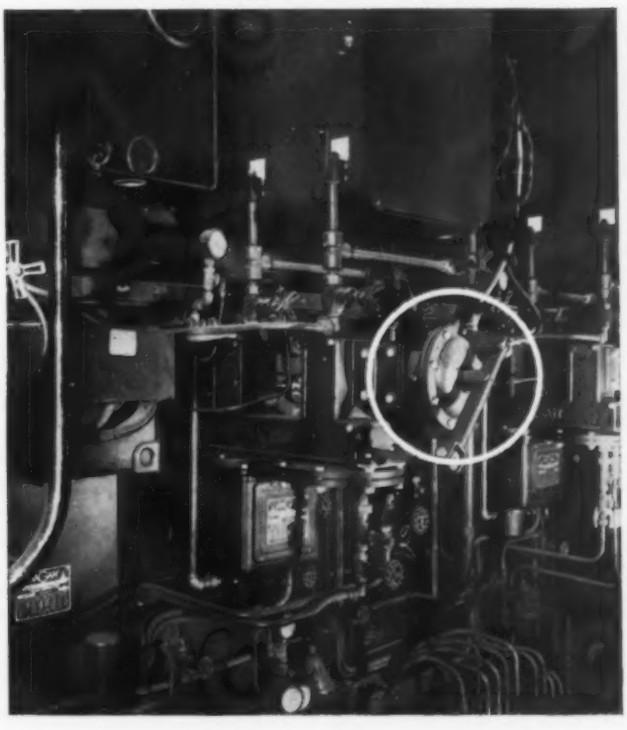
By means of an air temperature transmitter, connected to a thermocouple in the hot air duct, a pneumatic signal is transmitted to a diaphragm operator. This operator serves as a fulcrum positioner for the fuel-air ratio regulator, so that the ratio is maintained despite variations in combustion air temperature.

Hagan control systems are also used for collector flue draft control, pit pressure measurement, recuperator temperature control and measurement and for the safety systems. These various parts of the overall system are functioning accurately and dependably, and actual records show extremely low maintenance costs. To quote the Crucible engineers again, "Considering the types of steel being heated, controlled-heating cycles required, and track times, we believe the pits are doing an excellent job."

Reprints of an article, "Problems of a New Soaking Pit Installation" are available. Write for your copy.

Control panel for Crucible Soaking Pits.

Back of panel, showing double diaphragm fuel-air ratio control and (in circle) the temperature compensating fulcrum positioner.

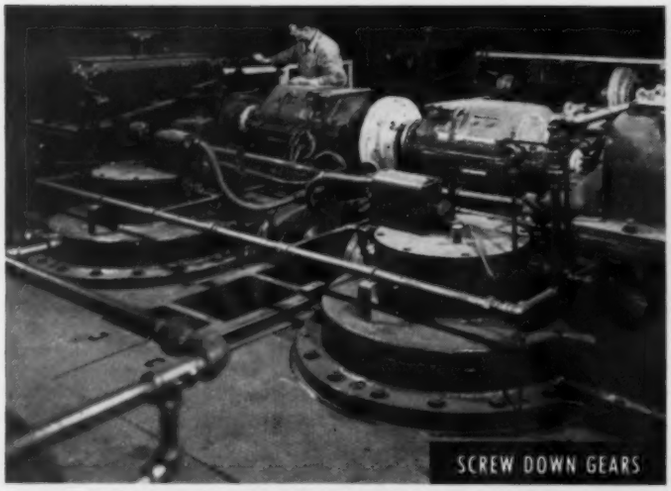


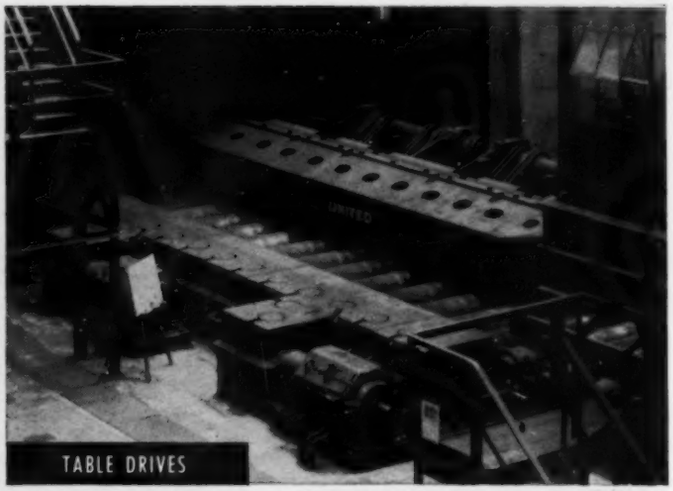
HAGAN CORPORATION

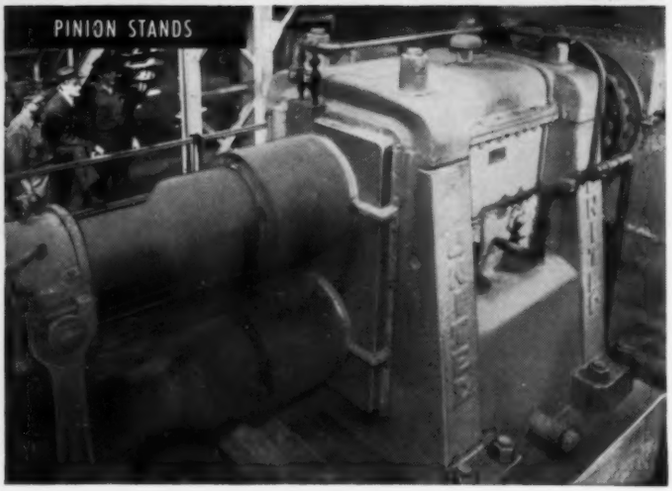
HAGAN BUILDING, PITTSBURGH 30, PA.

Systems and Components for: Metallurgical Furnace Control, Boiler Combustion Control, Process Control, Aeronautical Testing Facilities • Industrial Water Treatment • Chemicals for Water Conditioning

HAGAN SUBSIDIARIES: CALGON, INC. • HALL LABORATORIES, INC.







Get protection *plus* for your gear drives with GULF E.P. LUBRICANTS

Get the advantage of the extra load-carrying capacity of Gulf E.P. Lubricants, plus excellent water separating and rust preventive properties, plus exceptional stability for this type of lubricant, plus effective nonfoaming and noncorrosive characteristics.

This "plus protection" of Gulf E.P. Lubricants not only prevents excessive gear wear but insures freedom from rust, foaming, and other lubrication troubles.

The next time you order gear drive lubricants, make it an order for safe, sure protection and lower maintenance costs — specify Gulf E.P. Lubricants.

For more complete information, or for expert help on your gear drive lubrication problems, send the handy coupon.

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Gulf Oil Corporation • Gulf Refining Company
1822 Gulf Building, Pittsburgh 30, Pa.

Gentlemen:

I would like further information on Gulf E.P. Lubricants:

☐ Please have a Gulf Sales Engineer call. ISE

☐ Please send me a copy of your pamphlet "Gulf E. P. Lubricants for Reduction Gear Drives."

☐ Please arrange to show a group in our plant the Gulf Color Slide Film, "Gears and Their Lubrication."

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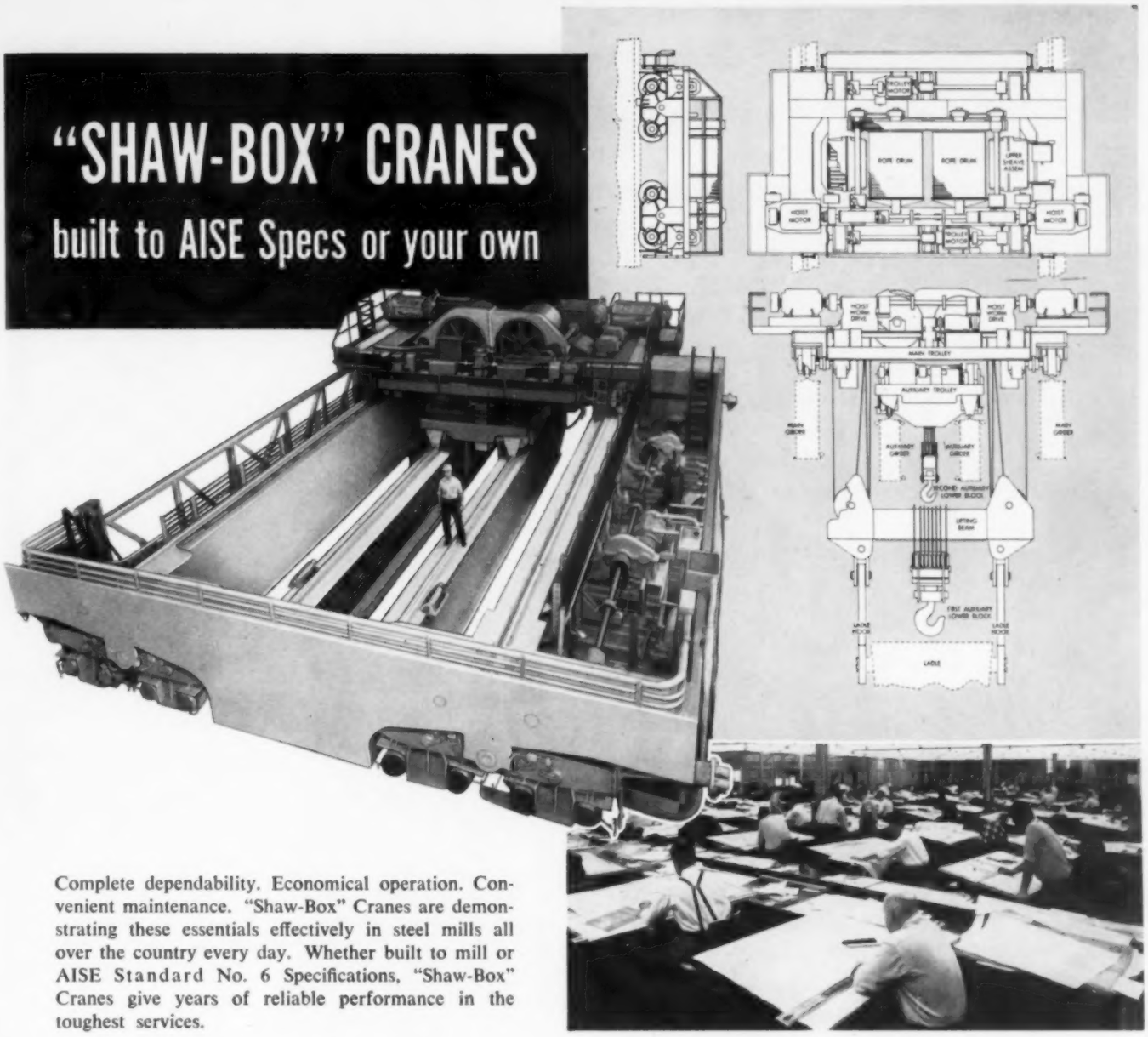
"SHAW-BOX" CRANES

built to AISE Specs or your own



Complete dependability. Economical operation. Convenient maintenance. "Shaw-Box" Cranes are demonstrating these essentials effectively in steel mills all over the country every day. Whether built to mill or AISE Standard No. 6 Specifications, "Shaw-Box" Cranes give years of reliable performance in the toughest services.

The giant "Shaw-Box" Ladle Crane pictured here raises a 90-ton ladle containing 200 tons of molten steel. An auxiliary crane, also a part of the unit, tilts the ladle for pouring into ingot molds. It is a 4-girder, 9-motor crane with 54-foot span. Creative engineering contributes *exclusive* structural, mechanical and operational advantages that assure rugged strength and functional perfection.

Make certain of experienced interpretation of your requirements, whether your plans include a ladle crane, a soaking pit carriage or a crane to handle plate or slabs. Our vast crane-building facilities and special manufacturing techniques can be of real value to you. We have standard AISE designs for 15 to 100-ton cranes, so you pay less for engineering and get more for your purchase dollars. Invite one of our engineers to discuss specifications. No obligation, of course.

Every "Shaw-Box" Steel Mill Crane first takes shape in the minds of our many engineers. Their know-how and inventive skills have created numerous "firsts" that are now accepted as standard in crane manufacture.

You are cordially invited to visit our Booth No. 263 — AISE Show, Cleveland Auditorium, September 25-28.

"Shaw-Box"® CRANES

MANNING MAXWELL & MOORE INC. M&M TRADE MARK

MANNING, MAXWELL & MOORE, INC.

SHAW-BOX CRANE & HOIST DIVISION, MUSKEGON, MICHIGAN

Builders of "SHAW-BOX" and 'LOAD LIFTER' Cranes, 'BUDGIT' and 'LOAD LIFTER' Hoists and other lifting specialties. Makers of 'ASHCROFT' Gauges, 'HANCOCK' Valves, 'CONSOLIDATED' Safety and Relief Valves, 'AMERICAN' and 'AMERICAN-MICROSEN' Industrial Instruments, and Aircraft Products.

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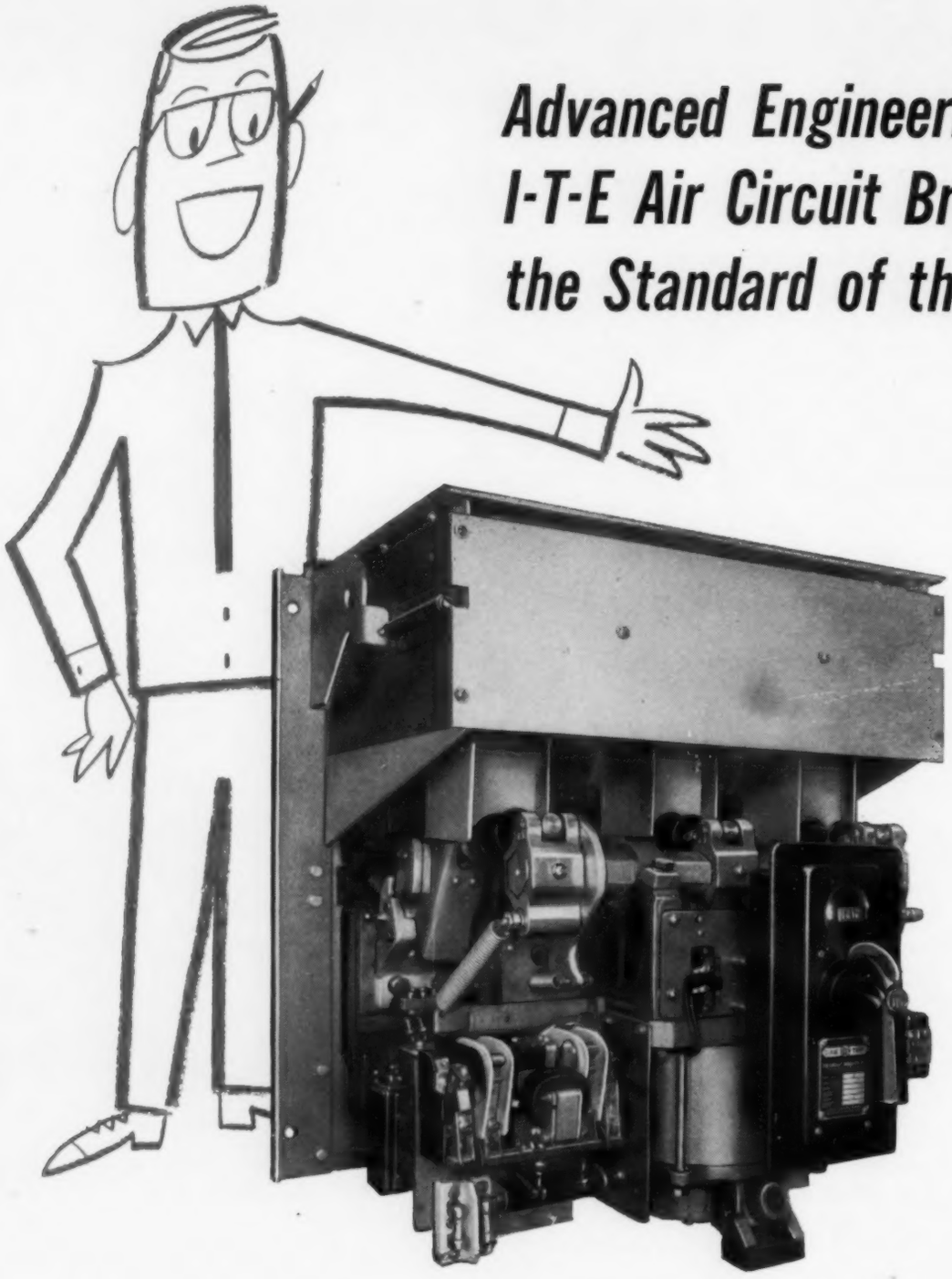
Advanced Engineering Makes I-T-E Air Circuit Breakers the Standard of the Industry



New design extends K line through 4000 amp continuous and 150,000 amp interrupting capacity

Here are some of the extra features that make the new K line of I-T-E circuit breakers the standard of the industry:

- Compact arc chutes designed to provide fast, efficient arc interruption
- Contact structure utilizing silver-alloy, wiping action, sturdy construction and blow-on arrangements to assure superior interrupting ability, and long life
- Dual magnetic overcurrent trip, dual selective overcurrent trip, and other auxiliary devices
- Standardized location of all tripping devices, solenoid relays, auxiliary switches and terminal blocks

For the complete story of I-T-E superiority, contact your local I-T-E representative. Or write for Bulletin 6004B, I-T-E Circuit Breaker Company, 19th and Hamilton Sts., Phila. 30, Pa.

I-T-E

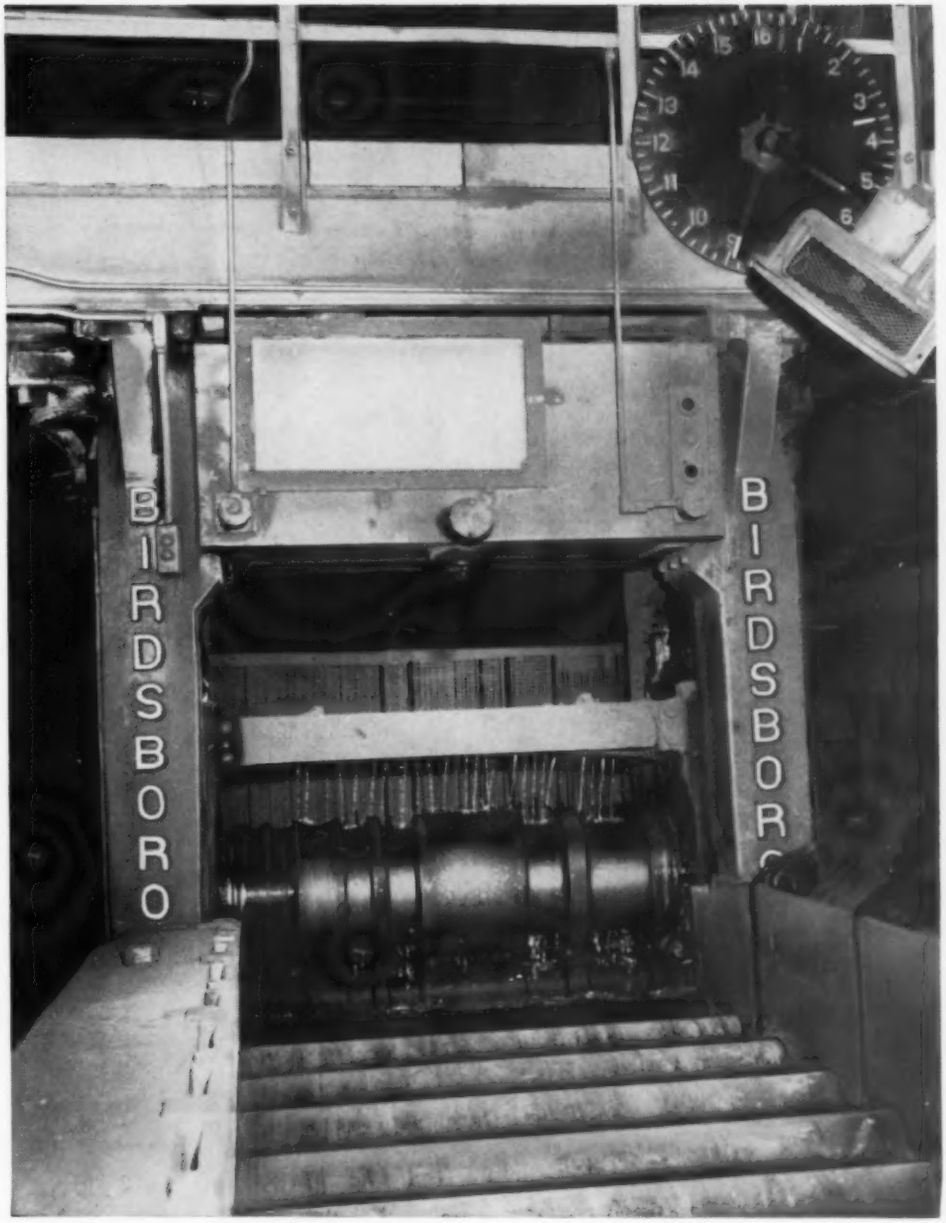
I-T-E CIRCUIT BREAKER COMPANY • Switchgear Division

Steel industry will add 60 million tons capacity at a cost of $17½ billions

With Expansion Plans On Paper, Steelmen Seek Ways to Cut Production Costs

By 1970, authoritative forecasts indicate that the steel industry will add another 60 million tons capacity to satisfy demand. Many producers are already "expansioneering" to new tonnage highs. Others have plans in the works. But the immediate question for steelmen is: how to produce *extra* tonnage while holding costs in line.

That's exactly why more and more plants are writing BIRDSBORO Rolls into specifications for new and larger mills. Why not let a roll specialist from BIRDSBORO explain the advantages you can get through individualized roll service.



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- HYDRAULIC PRESSES *(Metalworking and Extrusion)*
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- STEEL CASTINGS
- Weldments "CAST-WELD" Design
- ROLLS: Steel, Alloy Iron, Alloy Steel

IRON BASE ROLLS: Grainloy, Birdsboro Metal, Curoloy, Superloy, Super Curoloy

STEEL BASE ROLLS: Diamondite, Birdsboro Special, Birdsboro "30", "40", "50", and "75"

R-10-56

BIRDSBORO

BIRDSBORO STEEL FOUNDRY & MACHINE CO., Main Offices in Birdsboro, Pa. District Office: Pittsburgh, Pa.

New York Office: **Engineering Supervision Co.,** *120 West 42nd Street, New York 36, N.Y.*

Largest machine in United States for

now producing

KOPPERS designed and constructed the machine shown here for the Weirton Steel Company, Weirton, West Virginia—a division of National Steel Corporation. The iron-ore sinter produced on this machine makes possible a substantial reduction in blast-furnace coke rate and also increases pig-iron production.

This 8-foot-wide machine is now producing 2,400 net tons of high-quality sinter per day. It is the largest used in the United States for iron-ore sintering.

But it won't be for long.

Right now, also for National Steel, Koppers is designing and constructing two 12-foot-wide sintering machines. One machine will have the capacity to produce more than 7,000 net tons per day, thus making it the largest in the world.

These two new contracts from National Steel illustrate how important the sintering process has become to production men who must meet the heavy demand for steel.

Designing and constructing sintering plants is just one way in which Koppers serves the steel industry. For any kind of metallurgical construction, you can count on Koppers. You are invited to consult with our Engineers and Management.

KOPPERS COMPANY, INC.

PITTSBURGH 19, PENNSYLVANIA

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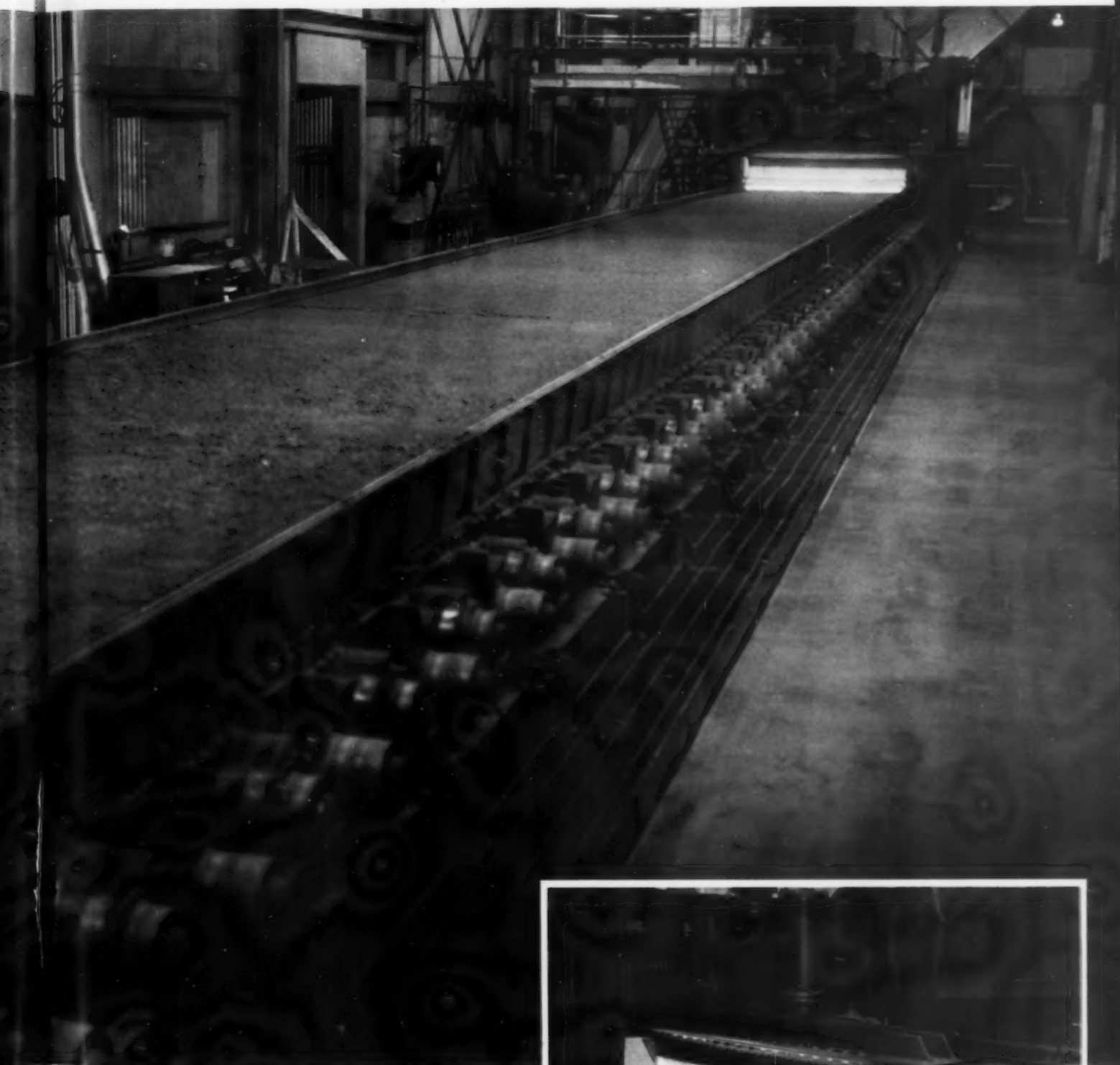
ENGINEERING AND CONSTRUCTION

iron-ore sintering

2,400 net tons of sinter per day



▲ *View of Weirton Steel's new 8-foot sintering machine, looking toward feed end. It is the widest iron-ore sintering machine in the United States.*

Inset shows ignition furnace and vibrating spreader feeder, which eliminates conventional swinging spout. ▶

For improved O-H combustion practice...

Record O_2 Reliably, Heat after Heat

Key to continuous, reliable records of oxygen in open-hearth exhaust gases is the unique L&N sampling system. Self-flushing, self-cleaning, this assembly delivers a thoroughly scrubbed sample of waste gas to the L&N Magnetic Oxygen Analyzer under positive pressure, without mechanical pumps or aspirators . . . and with very little maintenance.

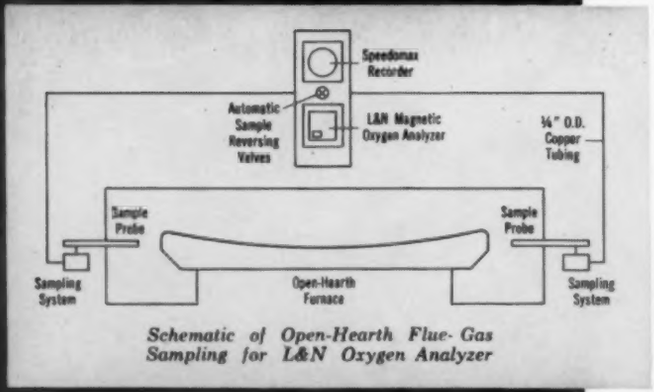
Spray-flushing of the probe opening and internal passages prevents slag buildup and dirt accumulation. The sample gas is drawn from the water-jacketed, stainless steel probe by a steam jet assembly. Expansion of steam accelerates the gas to a high velocity; condensation of the steam scrubs the sample by precipitating all dust and dirt. The cleaned sample travels at 50 ft./sec. in the sampling lines (quarter-inch copper tubing), so that initial response of the *entire* system is only about 10 seconds.

The Magnetic Oxygen Analyzer and the Speedomax G® recorder, calibrated directly in per cent O_2, may be located wherever convenient . . . are quickly checked against air to assure accurate performance.

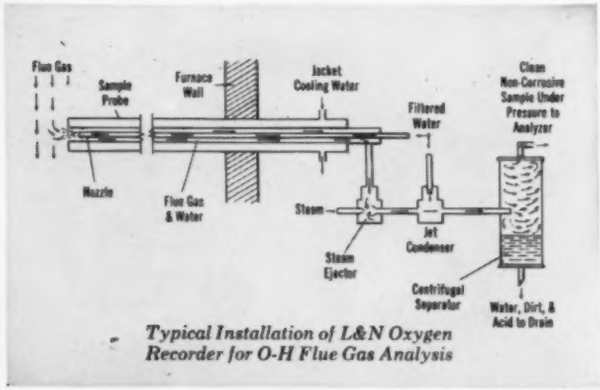
Complete description of this equipment is contained in Process Data Sheet 643(5), available from your nearest L&N representative. Or write us at 4934 Stenton Avenue, Philadelphia 44, Pa.

LEEDS & NORTHRUP
Instruments — Automatic Controls • Furnaces

In this O-H shop of Jones & Laughlin Steel Corp., Pittsburgh, the L&N O_2 Analyzer is used with a Speedomax G Controller, which adjusts a fuel-air controller (not shown) to provide automatic combustion control.



Schematic of Open-Hearth Flue-Gas Sampling for L&N Oxygen Analyzer



Typical Installation of L&N Oxygen Recorder for O-H Flue Gas Analysis

K&R Two-Plane Straightener

gives 2-machine performance in one operation

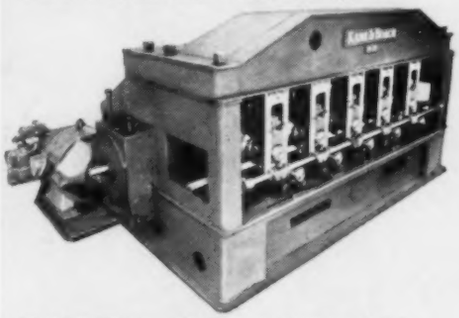
N-A-X

NATIONAL STEEL CORPORATION

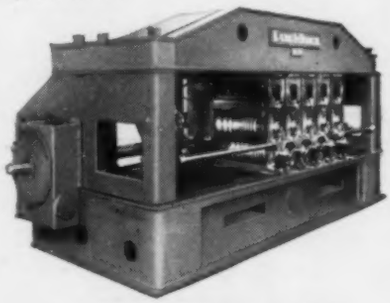
Straightening Spring and N-A-X Tensile Steels at Great Lakes Plant, Ecorse, Mich.

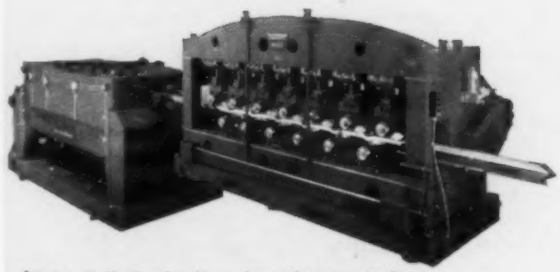
The K&R No. 2B-15 Roll Comb. Vert. and Hor. Straightening Roll, Type B, shown in use at the Great Lakes Steel Corporation, Detroit, Michigan, Division of National Steel Corporation, has continued to give satisfactory service since its installation in 1936. This Two-Plane straightener gives the flexibility of operation needed for edge and flat straightening of rectangles, squares, hexagons and other shapes. Flexibility that gives you the advantage of two-machine operation in one pass. *Illustrated are the modern K&R 2B Straightening Rolls, both Two Plane and Single Plane Types.*

Learn how K&R Machinery can cut costs and boost production in your plant. Our engineers will furnish recommendations, operating data, estimates—no cost, no obligation. Write or wire today.



2B-10 Roll Hor. Shaft Straightening Roll, Type B, shown at maximum longitudinal centers, above, and minimum longitudinal centers, below.





2B-24 Roll Comb. Hor. Straightening Roll, Type B.

2B-16 Roll Comb. Hor. and Vert. Straightening Roll, Type B.

Metal Working Machinery Since 1887

Cold Roll Forming Machines
Bending Rolls Straightening Rolls
Slitting Lines Flying Shears & Saws
Special Metalworking Equipment

Kane & Roach
INCORPORATED
SYRACUSE, NEW YORK • ESTABLISHED 1887

How perfectly simple —this Fast's Coupling with purely mechanical flexibility!

1. A hub is keyed on each shaft. Hubs are splined at maximum distance from shaft ends.

2. Floating sleeves surround hubs. Sleeves are splined to engage hub splines.

3. Sleeves compensate for shaft misalignment by assuming neutral position between two hubs.

4. Because of distance from shaft end, any misalignment between splines is mere fraction of same misalignment between shafts.

5. Sleeves carried on bearing rings, located on *transverse center line of hub spline faces* (the load-carrying surfaces) . . . no crank action, no vibration.

6. Lubricant is centrifugally forced into spaces between engaged splines, forming a film.

For 35 years the most positive, dependable means of coupling machines to their power source . . . Fast's Couplings have no parts subject to repeated bending, tension or compression. Because there is no metal-to-metal contact, *there is no wear*—in fact, many Fast's Couplings in use for over 30 years show no signs of wear when disassembled! No leather, plastic or rubber oil seals. Lubricant film distributes pressure over a considerable area, diminishing localized stress at pressure points on the load-carrying teeth. Perfectly simple? Yes . . . and foolproof!

For coupling catalog, technical advice or assistance from Koppers field engineers, write: KOPPERS COMPANY, INC., *Fast's Coupling Dept.,* 3009 Scott Street, Baltimore 3, Maryland.

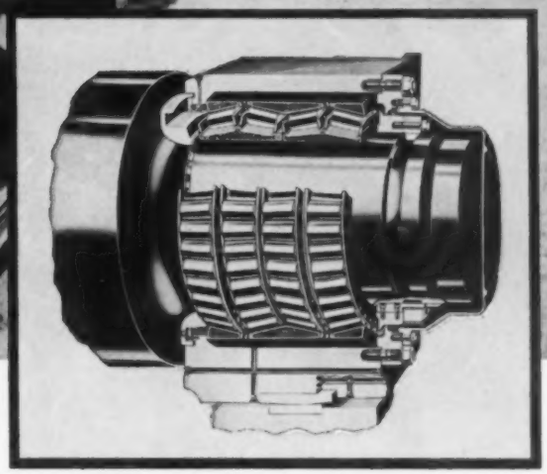
THE ORIGINAL **FAST'S Couplings**

KOPPERS

METAL PRODUCTS DIVISION • KOPPERS COMPANY, INC. • BALTIMORE 3, MD.
This Koppers Division also supplies industry with American Hammered Industrial Piston and Sealing Rings, Industrial Gas Cleaning Apparatus, Aeromaster Fans.
Engineered Products Sold with Service.

NOW-- All TIMKEN Steel Mill Bearings are available from BERRY BEARING COMPANY

View of work rolls and back-up rolls in a mammoth 80 inch hot strip mill—one of the major producers of its kind in the world



Order from Berry--save time, effort, paper work

YES, it's true--Berry Bearing Company is now in a position to give steel mill customers fast service on ALL types of Timken bearings in formerly restricted sizes.

Thus--at no increase in price--Berry can now take care of *everything* steel mill customers require in the Timken bearing line—roll necks, screwdowns, table rolls, pinion stands, coils, etc. Ultimately, Berry plans to carry in stock *every* type and size of Timken steel mill bearings used throughout the entire Chicago district, and have them ready for--immediate delivery.

As usual, with over 50,000 other items in stock, Berry can give you immediate delivery on any type, and any size of bearing or bearing specialty you require. What do you need? A phone call--NOW--will start it rolling your way a few minutes later.

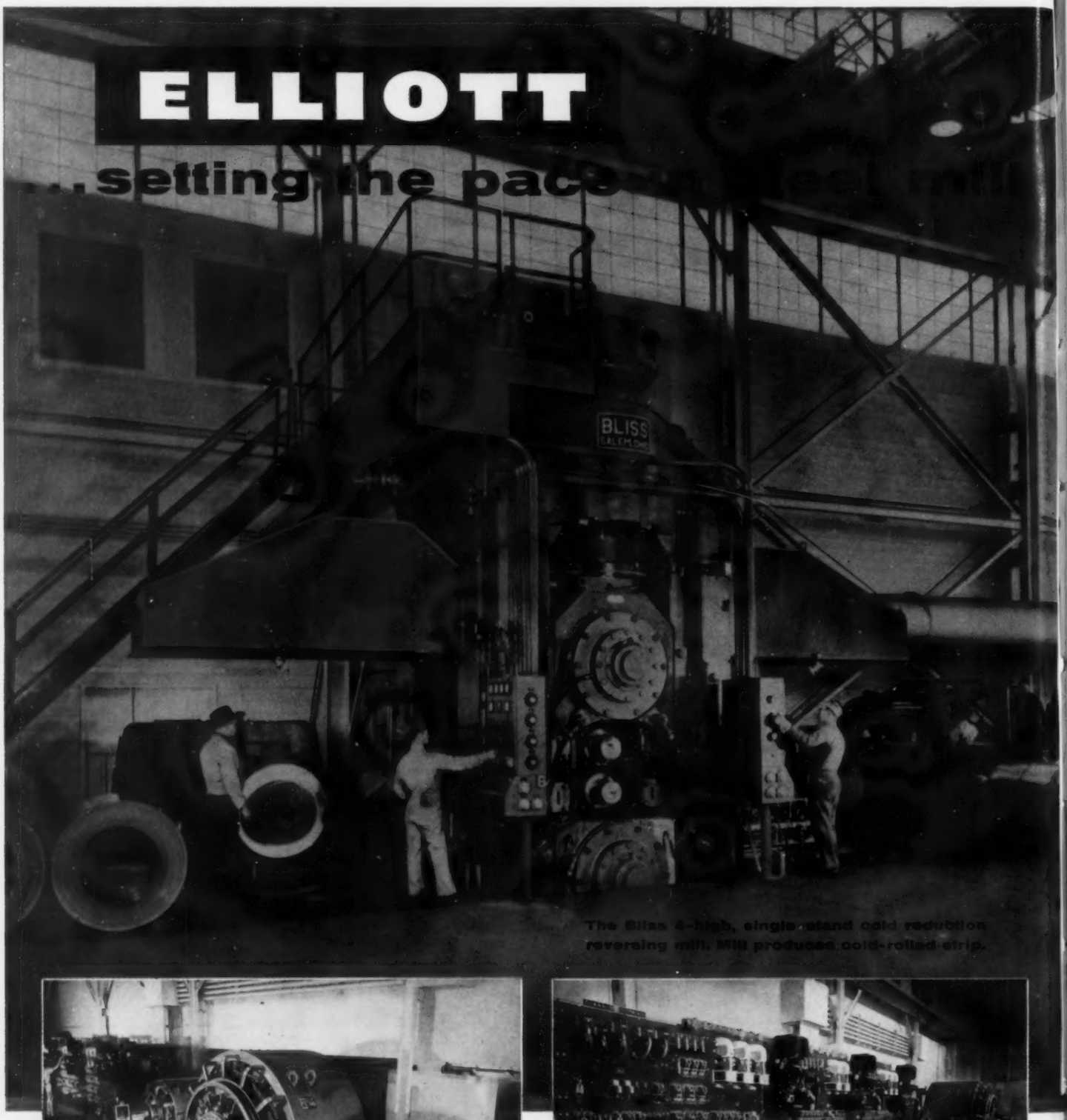
MEMBER AFBDA ANTI-FRICTION BEARING DISTRIBUTORS ASSOCIATION

BERRY BEARING COMPANY

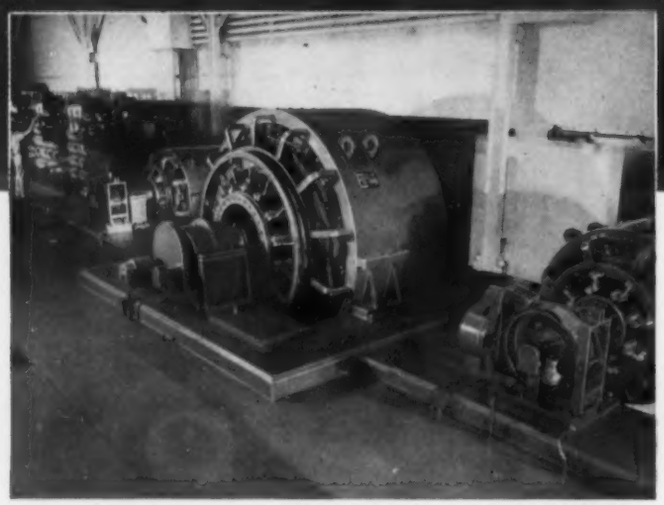
All phones--DAnube 6-6800

2633 S. Michigan Ave. Chicago 16, Illinois

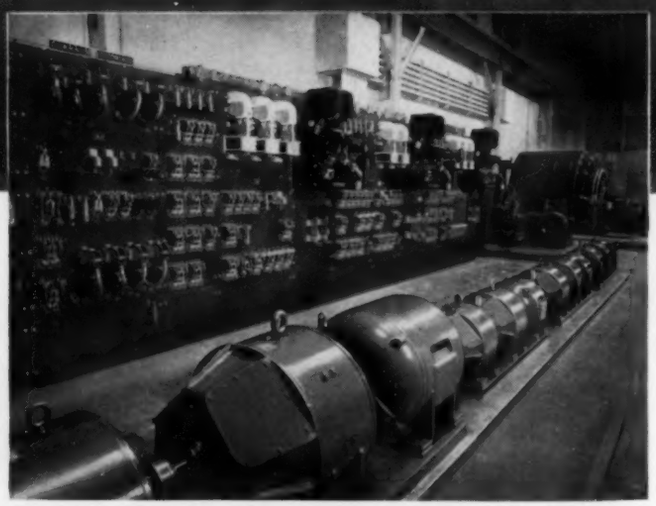
SOUTHWEST	OAK PARK	ROCKFORD	HAMMOND	GARY
6923 W. Archer Ave	327 Madison St.	710 Broadway	4828 Calumet Ave.	716 E. 5th Ave.
LUdlow 5 4400	EUclid 6 1700	Phone 2 5561	WEstmore 1 3010	TUrner 5 7501



The Bliss 4-high, single-stand cold reduction reversing mill. Mill produces cold-rolled strip.



The Elliott 3000-hp, 150/375-rpm, 600-volt main mill drive motor (middle), is flanked by two special low inertia 1000-hp, 300/900-rpm, 600-volt motors with magnetic brakes which furnish power to the reels.



The d-c control board—the complex nerve center of all the d-c machines. Elliott C-W exciter sets are in the foreground. Elliott engineered the complete job, including switch-gear, controls and rotating equipment.

rotating electrical equipment!

NEWPORT STEEL CORPORATION'S NEW REVERSING COLD MILL

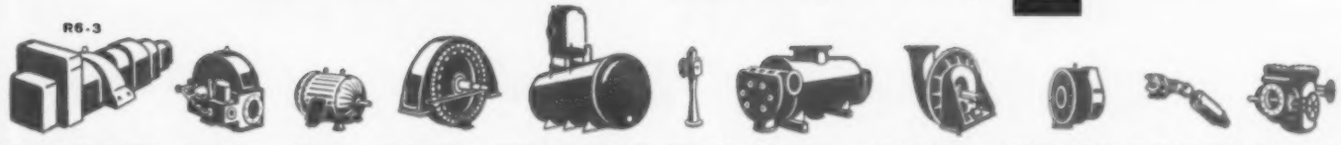
When Newport Steel dedicated its new four-high reversing cold mill in January, 1955, it marked not only the completion of one of the most modern and advanced mills of its kind but also a record-breaking construction and installation job. Erection of the mill began August 30th, and the *first test run of steel was rolled three months later!*

Part of the story behind this rapid completion can be found in the speed and efficiency of Elliott application engineering and manufacturing. *Elliott furnished and engineered all electrical apparatus, including controls, switchgear and ventilating equipment.* Pictured below are some of the large Elliott rotating electrical equipment, including the main m-g set, the 3000-hp main mill drive motor, the reel motors, and a number of auxiliary motors and other machines.

The application of Elliott equipment on jobs like this is coordinated by the Elliott Industry Engineering Department, which includes men with extensive experience in steel and related fields. For complete, up-to-the-minute information on Elliott steel mill equipment, write Elliott Company, Ridgway, Pennsylvania.

The Elliott motor-generator set. At left, the two 800-kw, 600-volt d-c generators (one for each reel drive motor). In the center, the 4500-hp, 13,200-volt, 514-rpm synchronous motor driver and, at right, the 2500-kw, 600-volt d-c generator which serves the main mill motor.

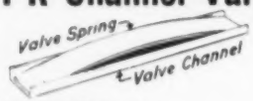
ELLIOTT Company



A SPACE-SAVING, READY-TO-GO

125 hp TWO-STAGE AIR-COOLED MOTORCOMPRESSOR

- Easy to install
- No water jackets or piping
- No freezing problem
- Air cooled intercooler
- Constant speed or dual control
- I-R Channel Valves

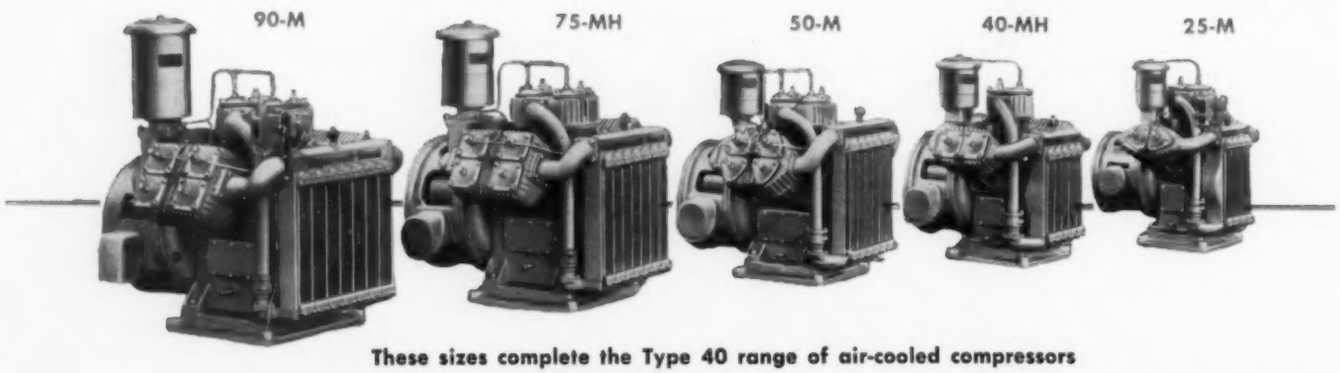


High Efficiency
Quiet Operating
Exceptional Durability
Entirely Different
Stainless-steel Channels and Springs
Air-cushioned action
Found only on I-R compressors

Newest addition to the Ingersoll-Rand line of Type 40 compressors, this heavy-duty, air-cooled unit offers new convenience and economy for the generation of 80-125 psi air power in the 125 hp class. Shipped fully assembled, its compact, well-balanced design and small foundation requirements cut installation costs. And efficient two-stage compression with intercooling to near ambient temperature, reduces power costs all year around.

Choice of constant-speed control, automatic start-and-stop control and manual or automatic dual control affords the most efficient capacity regulation for your particular operating requirements.

For complete information on all the time-saving, cost-saving features of this 125-hp Motorcompressor, send today for your copy of Bulletin 3188.



These sizes complete the Type 40 range of air-cooled compressors

Ingersoll-Rand

I-403

11 Broadway, New York 4, N. Y.

COMPRESSORS • GAS AND DIESEL ENGINES
ROCK DRILLS • PUMPS
TURBO-BLOWERS • AIR AND ELECTRIC TOOLS

IN ELECTRIC-WELD PIPE AND TUBE MAKING

Yoder leads the way

to higher speeds and quality at lower cost

In the short period from 1938 to 1955, the production of electric welded pipe and tubing grew from 269,000 tons to over 3,000,000 tons. This phenomenal rate of growth—over two and one-half times faster than that of the pipe and tube making industry as a whole—to a large extent resulted from a series of important improvements in tube mill design, all introduced by Yoder.

First came the Yoder rotating welding transformer, in 1938. The economic and other benefits conferred by this epoch making innovation were further augmented by other technological advances scored by Yoder in the years that followed. The result was that electric-weld pipe and tube making became the child prodigy of the fast growing pipe and tube making industry.

Latest, and perhaps the greatest, of these developments is the cold forming and induction welding at high speeds of *aluminum, magnesium, brass, nickel, monel, and other non-ferrous metals and alloys.* This process is especially economical for making light and medium gauge tubes in sizes up to 8 in. dia. More and more leading non-ferrous metal producers and fabricators are installing these mills.

More complete information about this and other interesting Yoder developments in pipe and tube mill equipment may be had merely by asking for any of the following publications:

- ☐ Resistance-Weld Mills for making Steel Tubing up to 4" diameter.
- ☐ Induction-Weld Mills for making Non-ferrous Tubing.
- ☐ Resistance-Weld Mills for Steel Pipe up to 24" diameter.

THE YODER COMPANY

5495 Walworth Avenue **Cleveland 2, Ohio**

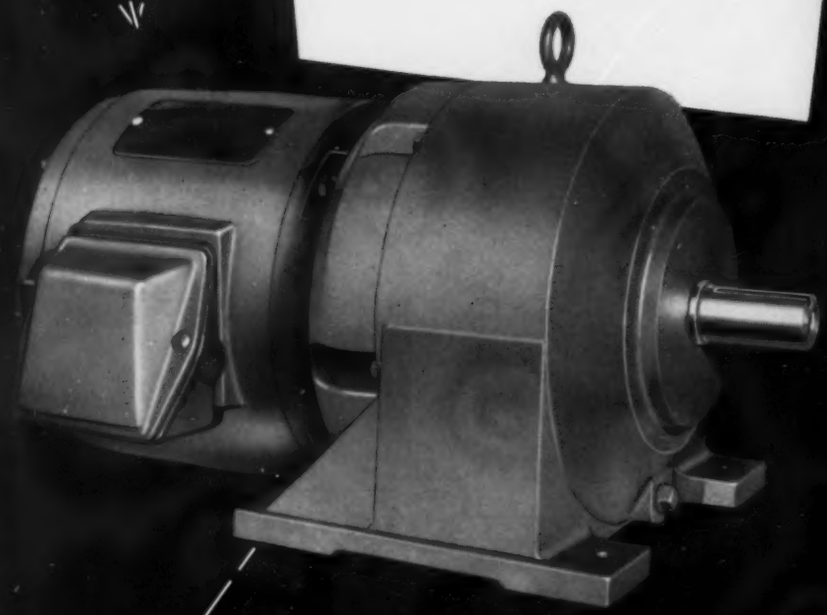
ENGINEERING YODER MANUFACTURING

PIPE AND TUBE MILLS—Electric Weld

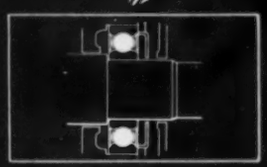
ROTARY SLITTING LINES

COLD ROLL FORMING MACHINES

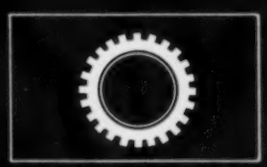
Don't overlook what you can't see



You can't always see what makes a gearmotor outstanding. It's the attention paid to small design details that makes the difference. Here are a few of the details that make the new Reliance Gearmotor stand above the rest.

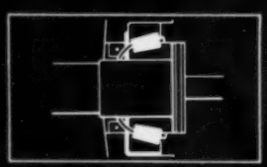


FOOLPROOF METERMATIC motor bearing lubrication and oil bath gear lubrication for long-life protection against wear.



INDUCTION HARDENING of the tough alloy steel gears gives a perfect combination of wear resistance and strength.

SIMPLIFIED GEARING with few moving parts reduces friction losses and lessens chances of breakdown.



THRUST BEARINGS handle heavy overhung loads safely by placing strain on the frame instead of the shafts.

Find out the complete story for yourself—contact your Reliance representative or write for Bulletin E-2408.

E-1509

REDUCE SPEED

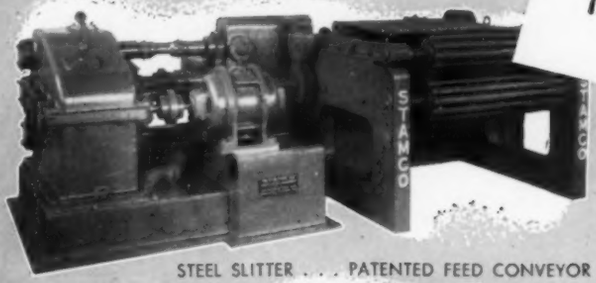
RELIANCE ELECTRIC AND ENGINEERING CO.

CLEVELAND 10, OHIO · OFFICES IN PRINCIPAL CITIES

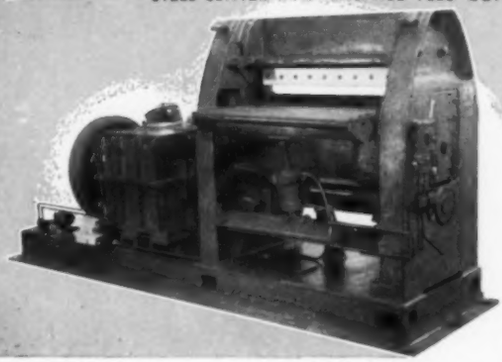
Canadian Division: Welland, Ontario

For Special Operations in Steel Mills...

PAY-OFF OR UNWIND REEL



STEEL SLITTER . . . PATENTED FEED CONVEYOR



UP-CUT SHEAR

REWIND REEL

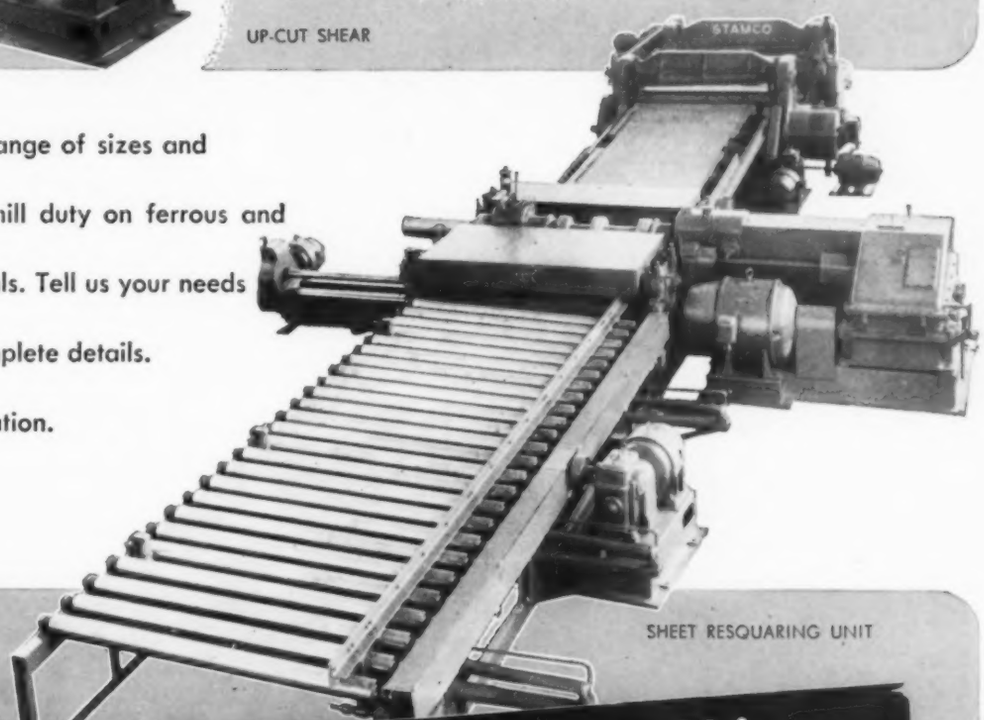
—call or write

Stamco

for the equipment you need

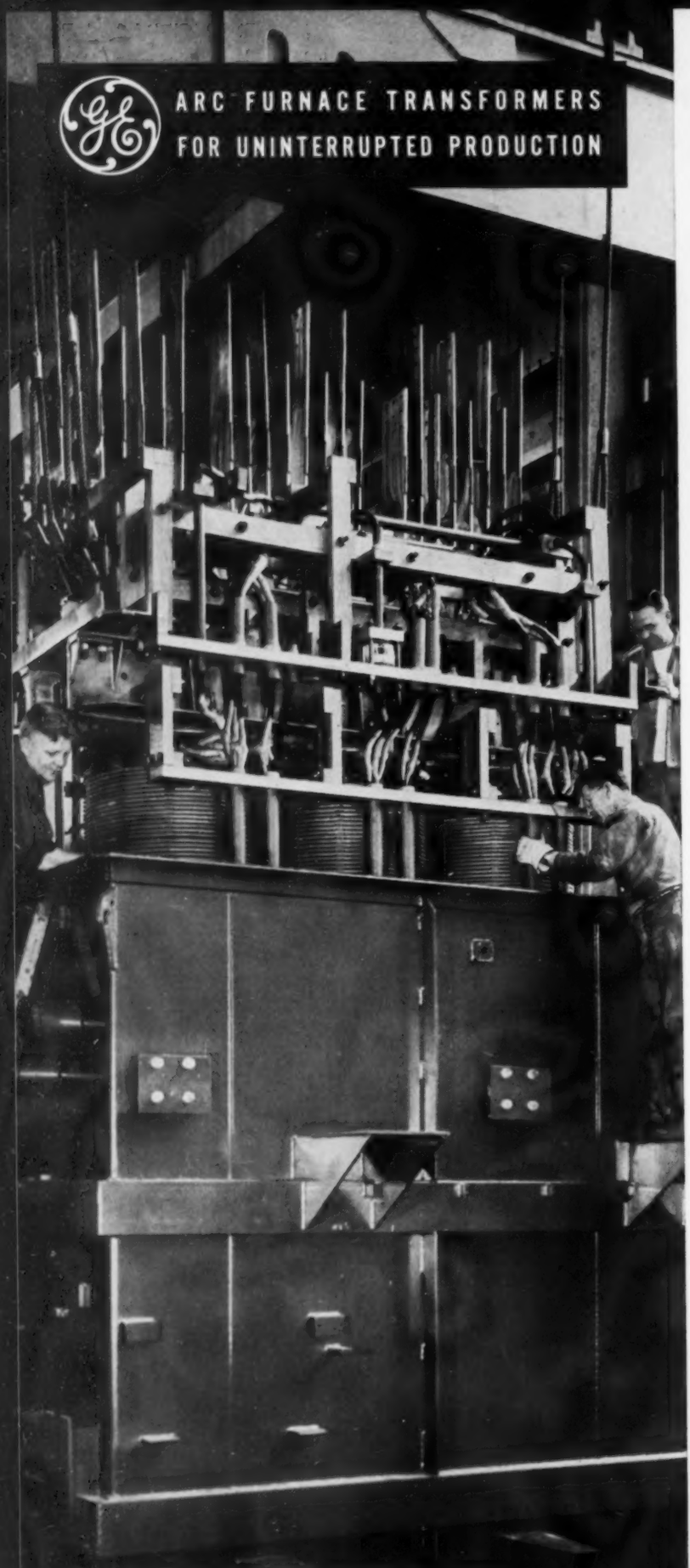
Available in a wide range of sizes and speeds for warehouse and mill duty on ferrous and non-ferrous materials. Tell us your needs and we'll give you complete details.

No obligation.



SHEET RESQUARING UNIT

STAMCO, Inc., New Bremen, Ohio



MORE DEPENDABLE TRANSFORMERS: Core-type construction with circular-concentric windings makes G-E transformers best able to withstand the innumerable jolting forces encountered in arc-furnace operation.

G-E transformers keep your furnaces on the job

HERE'S WHY:

TREMENDOUS AND FREQUENT current surges during the meltdown period subject the windings and core clamps of furnace transformers to severe pounding stresses found in no other transformer application. The low-voltage bar-lead structure may also be subjected to forces more than 1000 times those encountered in normal power-transformer operation. General Electric Arc-Furnace Transformers are designed and built especially for this rugged service.

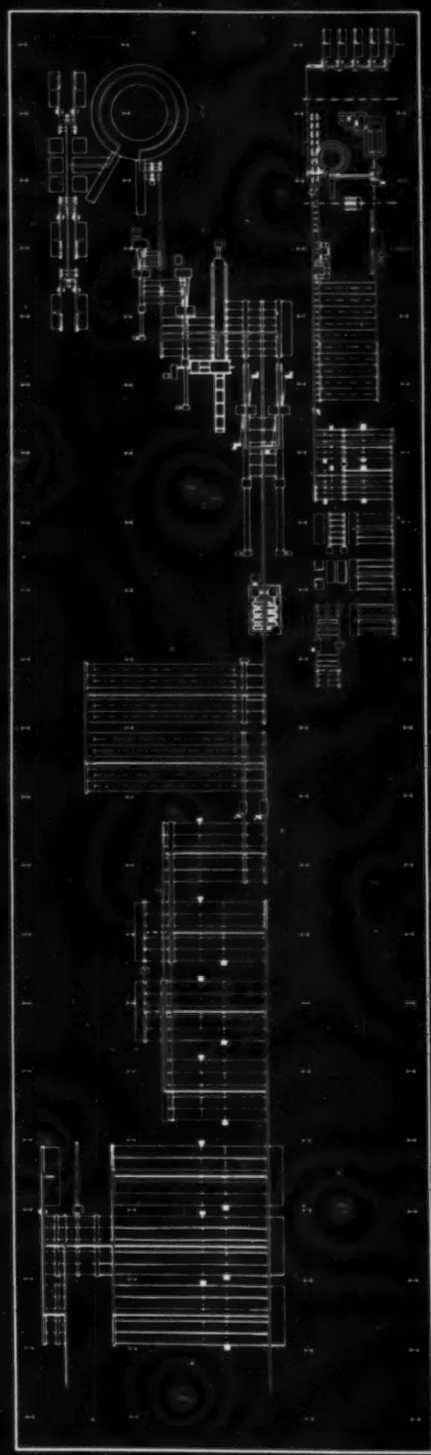
INHERENTLY STRONGER. Circular-concentric windings, used in all G-E transformers, are inherently stronger than other designs. A circular coil is far better able to withstand radial stress (the kind imposed by current surges), than a coil of any other shape. These coils are kept in place by a sturdy clamping structure, to prevent any shifting or deformation which could lead to failure.

GREATER STRENGTH is only one of many reasons why you should specify G-E transformers for your next arc-furnace installation. Others include: better cooling for more accurate control of hotspots, and a superior tap changer which has proved itself by a record of no contact-tip failures in over eighteen years.

For the full story, contact your nearest G-E Apparatus Sales Office or write to General Electric Company, Section 422-28, Schenectady 5, N. Y.

Progress Is Our Most Important Product

GENERAL ELECTRIC



Is there a standard way to build a tube mill?

Not according to what we've learned in many years of building and equipping tube and pipe mills.

Mannesmann-Meer's NO to this question is dictated by two factors – the individual needs of our various customers and the steady progress we build into our equipment.

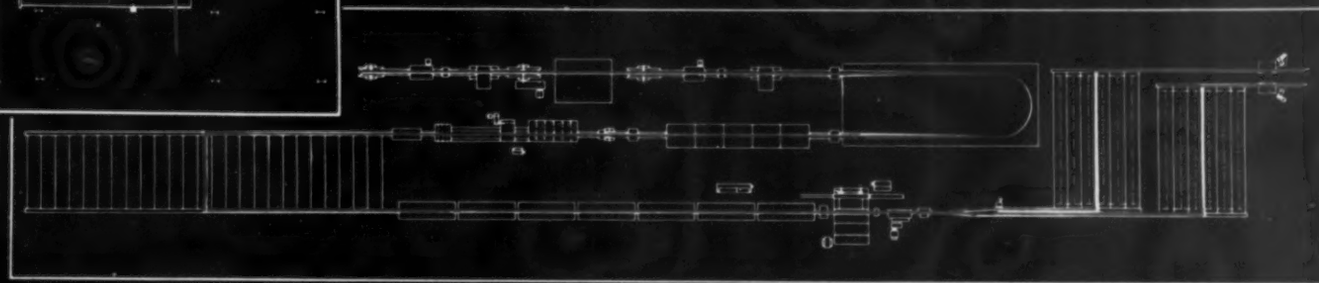
Here is an example. Economic needs and often other considerations lead many Companies into installing a new mill step-by-step. This procedure sometimes has marked advantages which show up in the mill layout and in the integrated planning for future steps of expansion, all of which will then be up-to-date. On the other hand mills for certain tubular products which must be installed all at once present different problems in plant engineering – with different solutions.

Meeting your individual needs and requirements is second nature for us. Nowhere else in the world is Mannesmann-Meer's combination of

- CREATIVE ENGINEERING
- DESIGN EXPERIENCE
- OPERATING BACKGROUND
- AMERICAN MANUFACTURING SKILL

available and ready to go to work on your tube and pipe mill problems.

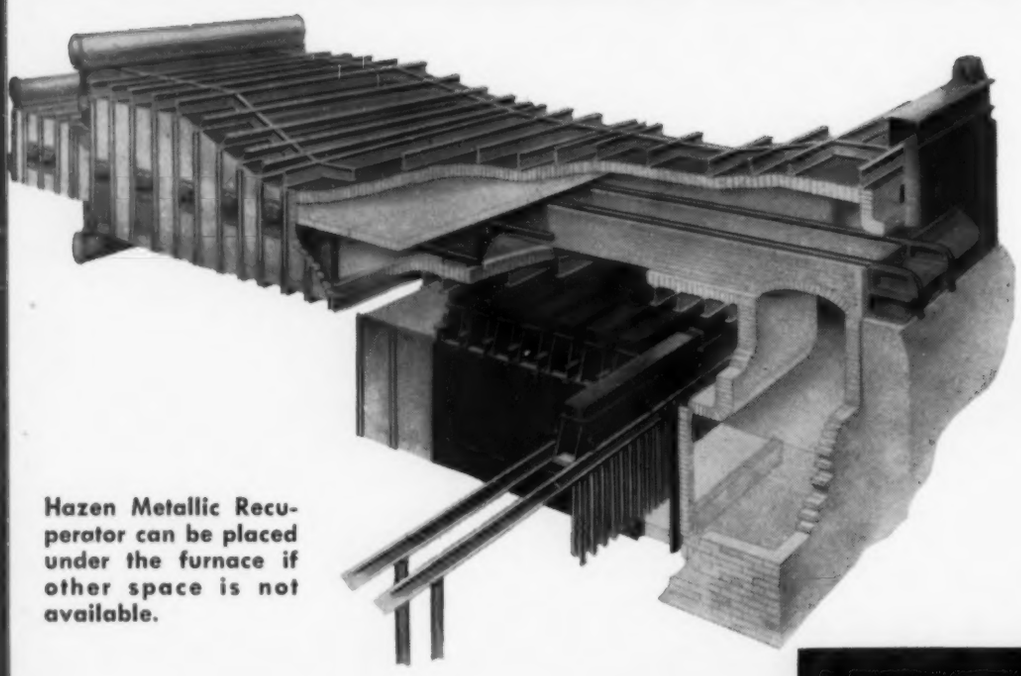
Mannesmann-Meer Engineering and Construction Company, Inc.,
900 Line Street, Easton, Pennsylvania



MANNESMANN-MEER

World Specialists in High-Speed Tube Mill Machinery

Typical installation of Hazen Metallic Recuperators above 4 Slab Reheating Furnaces.



Hazen Metallic Recuperator can be placed under the furnace if other space is not available.

the only 100% American Metallic Recuperator

Consult us about improving the production and economy of <u>your</u> furnace operations

NOW IN OUR NEW PLANT

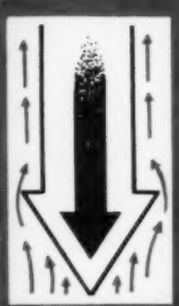
HAZEN *Metallic* RECUPERATORS

improve FURNACE production and economy

BY TAKING ADVANTAGE OF *"what comes naturally"* IN THE FLOW OF FLUE GASES FROM THE FURNACE TO THE RECUPERATOR

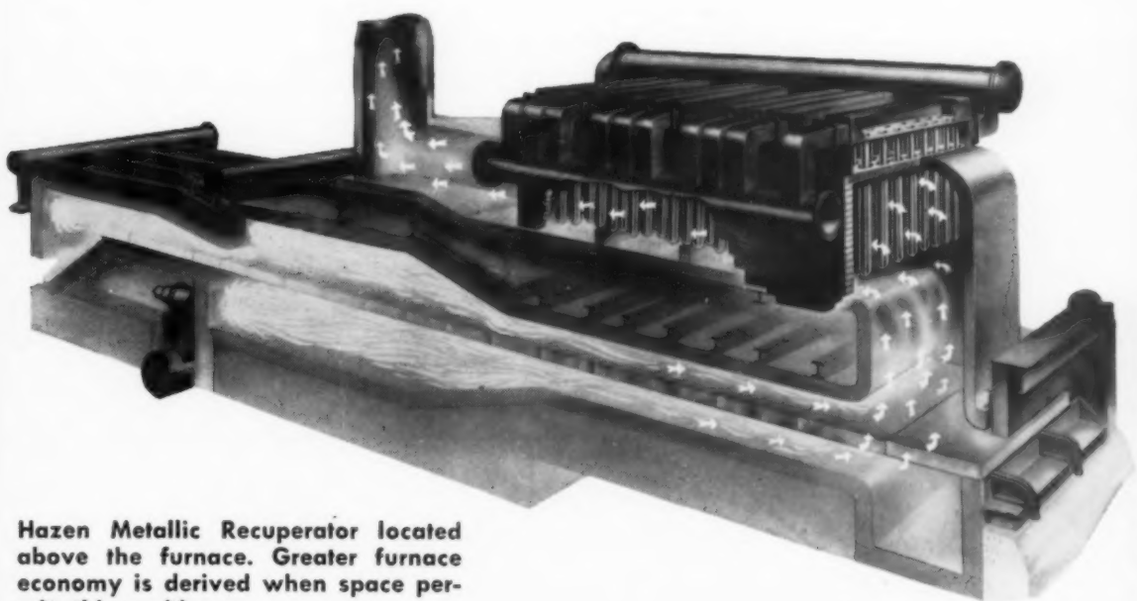
HAZEN RECUPERATOR FEATURES:

- Entirely made in U.S.A. All inner and outer tubes made of Stainless Steel.
- This application takes advantage of the natural upward flow of flue gases.
- Increased preheat . . . due to the availability of a larger percentage of flue gases at higher temperatures.
- Economies in initial cost . . . by reducing the required amount of excavating and furnace foundation . . . by reducing the length of flue ordinarily required from furnace to stack.
- Less stack draft is required.
- Recuperator, flue and stack may be supported from steel work independent of the furnace bindings.
- Walkways may be provided around the recuperator for convenience of inspection and cleaning.
- Recuperator may be applied above an existing furnace with a minimum loss in outage time.



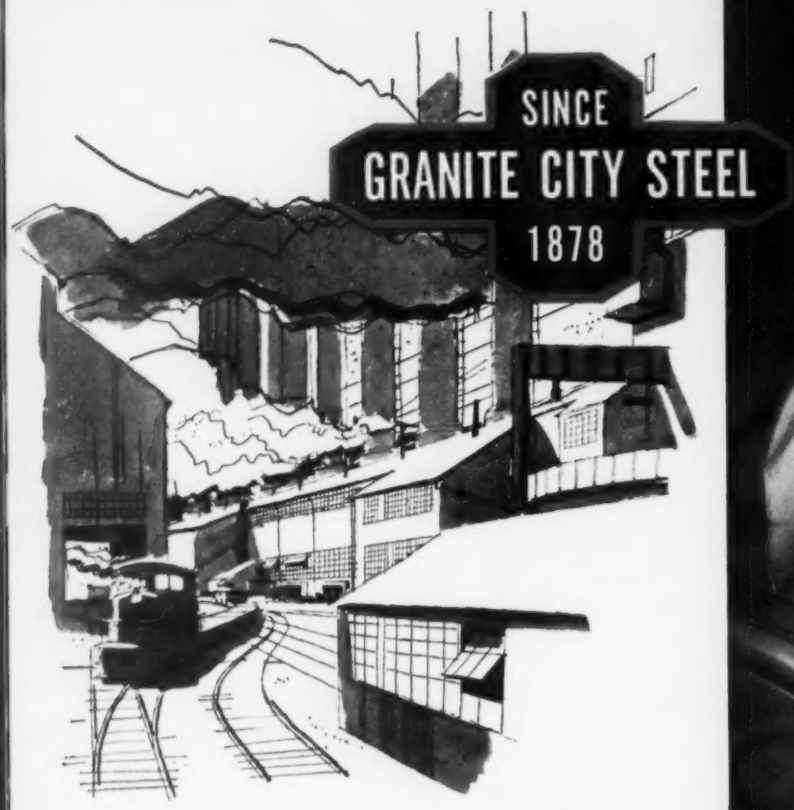
CONVENTIONAL APPLICATIONS
RESIST
THE NATURAL UPWARD
FLOW OF GASES

IMPROVED APPLICATIONS
ASSIST
THE NATURAL UPWARD
FLOW OF GASES



Hazen Metallic Recuperator located above the furnace. Greater furnace economy is derived when space permits this position.

HAZEN ENGINEERING COMPANY
184 Sandy Creek Road (PENN TOWNSHIP), P. O. BOX 10597, PITTSBURGH 35, PA.
Telephone CHurchill 2-1750



GRANITE CITY STEEL COMPANY...

"Keeps Rollin' Along"

And Allis-Chalmers steel mill equipment is helping in a new expansion program designed to increase steel production in mid-America

ALONG the banks of the mighty Mississippi, near the geographical center of mid-America, new steel-making facilities are being planned. Granite City Steel Company is planning another major expansion program which will raise their ingot production 30% by early 1958.

Just two years ago, Granite City Steel completed an $89,000,000 expansion. It was the culmination of a 7-year program, in which Allis-Chalmers supplied all major electrical requirements, bringing this midwestern plant up to maximum efficiency.

In this new modernization, Allis-Chalmers steel mill equipment will again play an important role. So far, Granite City has called on Allis-Chalmers for all the necessary electrical equipment needed to revamp their cold-strip mill, and the single-stand temper mill, plus other auxiliary machines.

Allis-Chalmers specializes in mill modernization and expansion. For specific information on drives, control and other electrical equipment for steel mills, contact your A-C representative, or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

Other Allis-Chalmers Products for the Steel Industry

Centrifugal Blowers • Axial Blowers • Arc-Furnace Transformers • Mercury-Arc Rectifiers • Rotary Compressors
Unit Substations • Switchgear • Circuit Breakers • Voltage Regulators • Power Generation Equipment

---

A-C ALLIS-CHALMERS

ALLIS-CHALMERS

A-5178

Regulex is an Allis-Chalmers trademark.

M-g sets supporting cold-strip mill motors. These units are rated at 7750 kw, 514 rpm. Furnished by Allis-Chalmers in 1946, they will be supplemented by new units.

M-G SETS

On the 56-inch temper mill, this 4-machine m-g set supporting the skin pass mill motors will be revamped. Two new 225-kw dc drag generator units will be furnished by Allis-Chalmers for this mill.

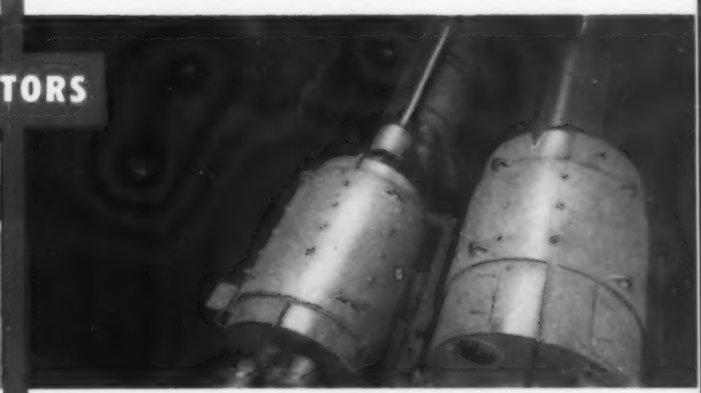
CONTROL

This variable voltage control board is used on the 56-inch tandem cold reduction mill. New control equipment is being furnished by Allis-Chalmers for new mill expansion at this midwestern steel plant.

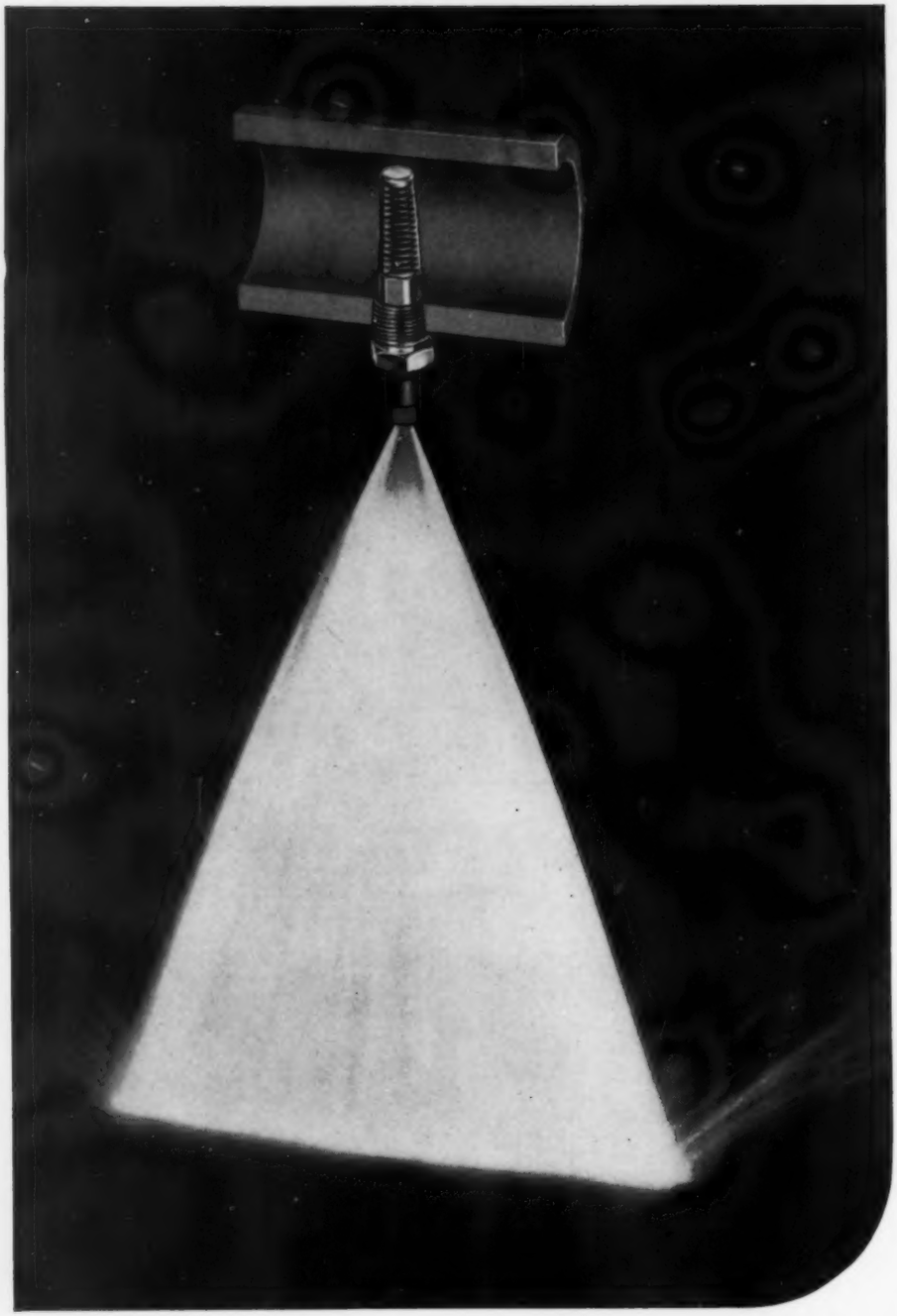
Regulex control and totally enclosed control board were furnished by Allis-Chalmers in 1948 for the 48-inch temper mill at Granite City Steel Co. Additional control is being furnished for the 56-inch temper mill.

MOTORS

Motor room view at this plant shows Allis-Chalmers units driving delivery reel and main stands. Allis-Chalmers motors furnish drive power throughout the plant. New motors, ranging in size from 25 to 5000 hp, are being installed.



Allis-Chalmers motors shown driving the temper mill include main roll drive, delivery tension, and delivery reel drive. Allis-Chalmers furnished original motors for both temper mills, as well as new motors for increasing capacity.



SPRAYING SYSTEMS

descaling NOZZLES

with open, elliptical non-clogging orifice

for performance *in full measure*

you can SEE the difference

When you consider performance in all its aspects, here are spray nozzles for descaling that give outstanding full measure. Descaling itself is carried out with an efficiency as high as or higher than any other nozzle made. But equally important, Spraying Systems nozzles give you low first cost . . . **plus non-clogging design** that **reduces** the cost of down-time and maintenance to a minimum.

The thin, concentrated, uniform spray strikes with greatest possible impact for any volume and pressure . . . descales without excessive sheet cooling.

Clogging is practically eliminated by *elliptical*-shaped orifice . . . foreign matter goes right through.

CHOICE OF SIZES . . . offered in 16 different capacities . . . for every known descaling use.

Designed and manufactured by America's leading producers of industrial spray nozzles. For complete information write for Data Sheet 6120.

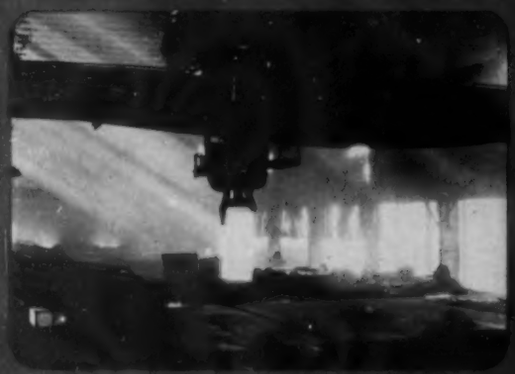
SPRAYING SYSTEMS COMPANY 3262 Randolph Street • Bellwood • Illinois

Spray Nozzles also supplied for such applications as Run-Out Table Cooling . . . Roll Cooling . . . Cooling Ingot Molds and many other uses. For complete information write for Catalog No. 24.

VICTOR R. BROWNING MILL TYPE CRANES TO SPECIFICATION...
Basically designed as required by A.I.S.E. specifications, mill type cranes built by Victor R. Browning & Co., Inc. also offer the opportunity of specifying preferences and standards prevailing in the purchaser's plant. May we have your next inquiry?
VICTOR R. BROWNING & COMPANY, Inc.
WILLOUGHBY (CLEVELAND), OHIO
DESIGNERS AND BUILDERS OF ELECTRIC OVERHEAD TRAVELING CRANES AND HOISTS AND ELECTRIC REVOLVING CRANES

from start to finish

Gears, track wheels, sheaves on ore bridges, heave

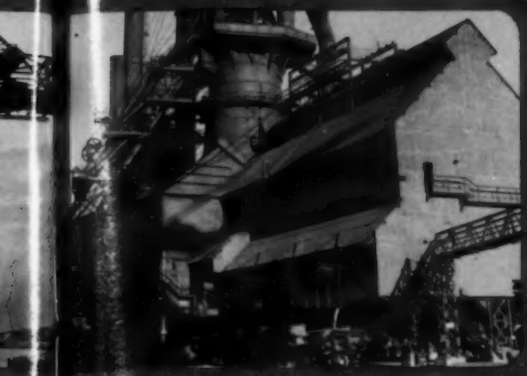


Gears, track and brake wheels, sheaves, axles, shafts, racks, on soaking pit cranes.

Screwdown screws, table gears, liner plates, manipulator gears and slides, on 46" blooming mill.

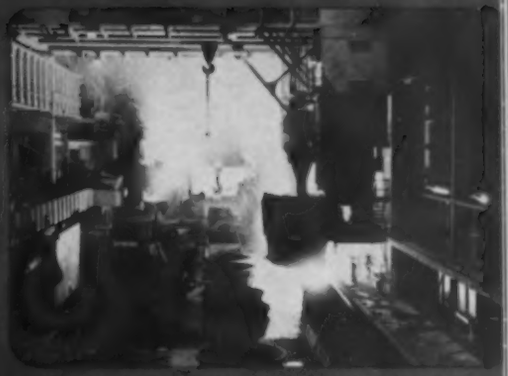
Table gears on new wide flange beam mill.

it's TSP at



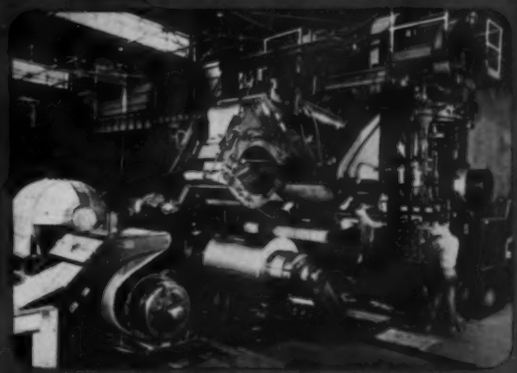
heaves, wheels, mud-gun screws and nuts on blast furnace equipment.

Gears, pinions, wheels on coke making equipment.



Gears, track and brake wheels, sheaves, axles, shafts, on open hearth equipment.

Table gears, crane gears and pinions, shafts, axles, brake and track wheels, on continuous hot strip mill equipment.



Work rolls, leveller rolls, pinch rolls, gears, pinions, racks, on cold strip mill equipment.

Table gearing on bar mill and hot bed tables run-out.

INLAND since 1911

THE TOOL STEEL GEAR AND PINION CO.

CINCINNATI 16, OHIO, U. S. A.

Getting finished material out of the mills and to storage as soon as possible helps eliminate congestion problems. This 1200° F., 32,000 lb. load is being moved to storage to cool. At Crucible Steel's Midland Works, the six Clark-Ross Carriers are moving material at an average of 450 tons each, per 8 hour shift.

Mill Congestion Problem?

LOOK WHAT CRUCIBLE DID!

How to handle and store in-process and finished material is a problem to most steel mills, no matter how modern. Faced with inflexible handling methods, congestion and lack of storage space, Crucible Steel's Midland Works took bold action.

In came six Clark-Ross* Carriers—open ground between buildings, next to roadways, and even outside doorways, became storage area for in-process materials.

Minutes after a call for material, a giant Carrier straddles a load, picks it up in seconds, delivers it *where* it's needed. Even hot steel is moved while at temperatures as high as 1400°F. These hot bars are cooled in storage rather than within the mill.

No need for tracks, cranes or special crews—the Clark-Ross Carrier's inherent mobility, speed and flexibility have made transportation between mill and outside storage practical. Full details. Write for Case Study 24-D1-33.

Every piece of open ground between buildings, next to roadways, and even outside doorways, has become storage area for in-process materials at Crucible Steel's Midland Works.

*Clark-Ross is a Trademark of Clark Equipment Company

CLARK® EQUIPMENT

Ross Carrier Division
CLARK EQUIPMENT COMPANY
Battle Creek 135, Michigan

A BETTER BUY WITH LOCAL SUPPLY—*Genuine Clark Parts*

USG® BRUSHES
work in a steel mill...

for every Steel Mill job—the right brush* specification

THE JOB	THE BRUSH
Mill Motors	USG Grade 135
DC Crane Motors	USG Grade 223
Diesel Main Generators	USG Grade AY 32 or 2306
Diesel Switcher Traction Motors	USG Grade 2207
Welding Generators and Exciters	USG Grade AH 897
Tin Line Collector Rolls	USG Grade 1658
Tin Line Generators	Grade on request
Cleaning Line Generators	Grade on request
DC Generators (DC Power Supply)	USG Grade 232
AC Crane Motor Slip Rings	USG Grade 550

*All USG brushes can be obtained with STATITE®, the permanent shunt connection, needing no hammerclips; cannot be jarred loose or pulled out.

Write for your copy of the complete USG Brush Catalog.

211

THE UNITED STATES GRAPHITE COMPANY
DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

SCHLOEMANN

Pressing Force 3,000 tons
Stroke of Ram 21 1/2 in.
Strokes/min. 6
Length of Table 33 ft.
Width of Table 6 ft.
Height above floor 23 1/2 ft.

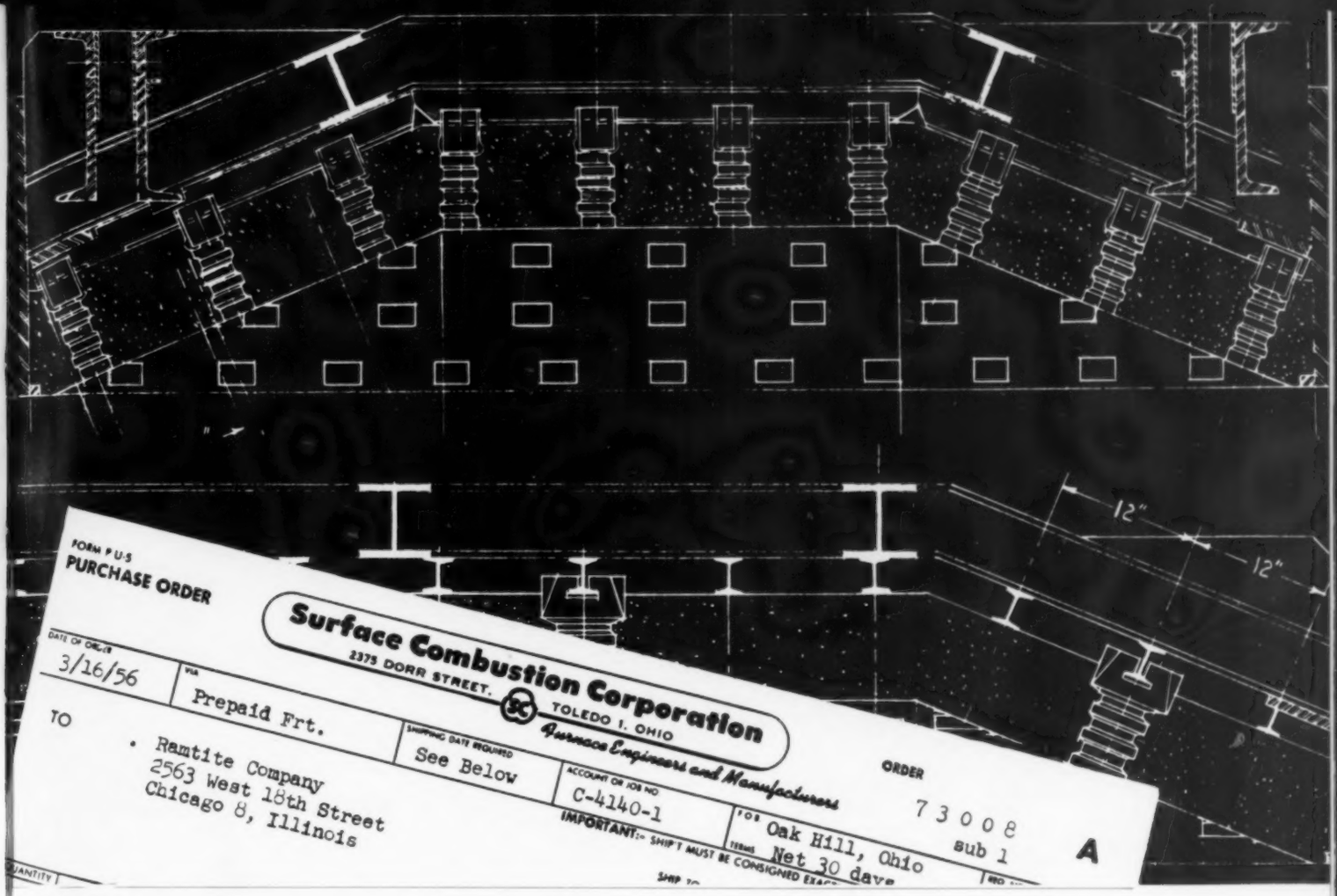
Mechanical toggle lever press for automobile- and airplane construction

for punching, perforating and bending of heavy beams as well as for drawing of plates and sheets. Its vast field of application and its special equipment make this press an exceptionally economical operating machine; this has been proved by years of successful operation.

Existing Equipment by **SCHLOEMANN**

Domestic users of equipment built by Schloemann are assured of competent service - engineering, supply of genuine spare, and repair parts. Call a Feller service engineer.

FELLER ENGINEERING COMPANY
1159 Empire Building, Pittsburgh 22, Pa.
Exclusive U.S. Agent



Ramtite's Proven Performance Paves Way To NEW FURNACE Orders

Ramtite's past performance record in an eastern steel mill led to the above purchase order for Ramtite to line eight new soaking pit covers and sections of new pit walls installed by Surface Combustion Corporation early this year.

In February 1953, eight soaking pit covers were experimentally installed in new pits. Four were lined with superduty firebrick, one with 3000°F. castable, one with insulating firebrick, and two with Special Super Ramtite No. 25.

One after another, the insulating firebrick, castable and superduty firebrick were replaced with Ramtite. The two original Ramtite covers are still in service and have required a minimum of maintenance.

The Ramtite Co. offers you a complete sales engineering service—experienced men who are always available to study your refractory problems and consult with your engineering, mason and ceramic departments about your specific needs.

For further information, contact your local Ramtite representative or mail the attached coupon.

VISIT OUR BOOTH Nos. 328-329 AT THE IRON & STEEL EXPOSITION

The Ramtite Co.
DIV. OF THE S. OBERMAYER CO.

THE RAMTITE CO., Div. of The S. Obermayer Co.
1813 South Rockwell St., Chicago 9, Ill.

Please send items checked

- ☐ Bulletin on Castable and Gunning Refractories
- ☐ Steel Plant Bulletin

Company Name_____

Attn. Mr._____ Title_____

Address_____

City_____ Zone____ State_____

© 1956

This is another in a series of advertisements depicting ways Ramtite Refractories serve the steel industry.

For the Indiana Harbor Works of

SWINDELL-DRESSLER
speed cold rolled

Phase 1
—1953

In 1953, Swindell-Dressler completed installation of the first phase of Youngstown's extensive program for cold rolled sheet annealing facilities of most modern type at Indiana Harbor. As shown above, the original installation included 14 Swindell furnaces for coiled sheet, each receiving four stacks of 72-inch diameter coils piled 156 inches high, and four Swindell furnaces for cut sheets. Forced cooling of all units is applied by means of a ventilated, pressurized basement.

We will be happy to arrange consultations on your annealing requirements, upon request.

SWINDELL-DRESSLER *Corporation*

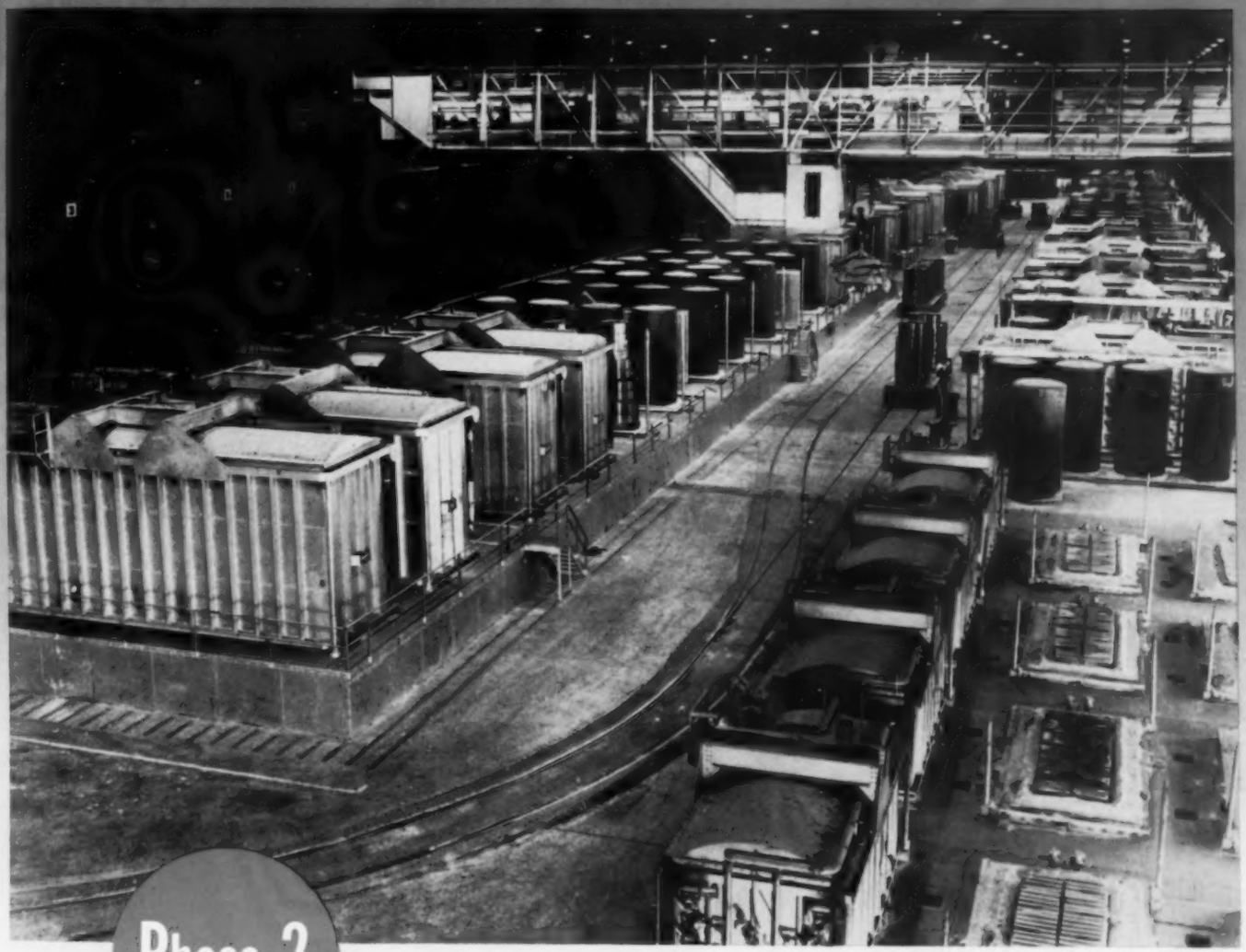
DESIGNERS AND BUILDERS OF MODERN INDUSTRIAL FURNACES

PITTSBURGH 30, PA.

THE YOUNGSTOWN SHEET AND TUBE COMPANY

ANNEALING FURNACES

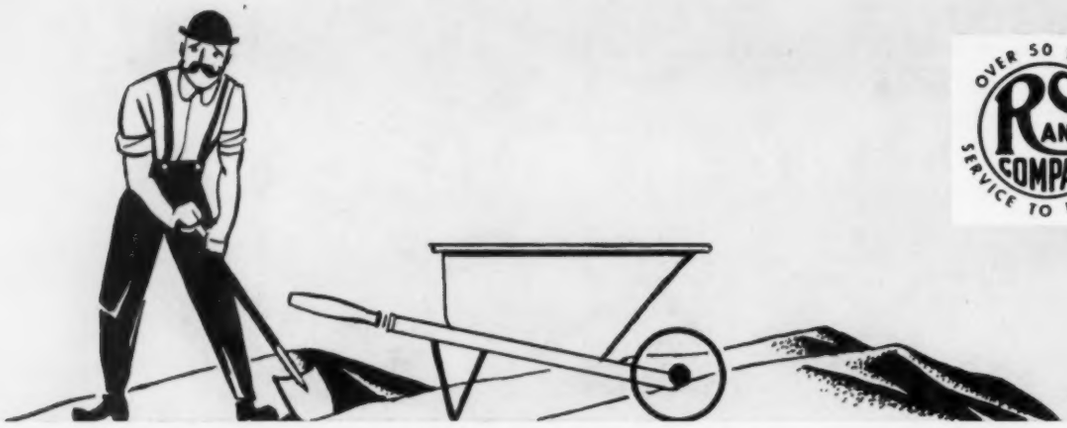
sheet production



Phase 2—1955

In 1955, in line with Youngstown's second major expansion of cold rolling operations, eight additional Swindell annealing furnaces were installed to process increased coiled sheet tonnage. These are pictured at left in the view above. Note the pressurized steel enclosure to provide forced cooling—elevated above the plant floor, this enclosure permits ready access when needed, and eliminated heavy excavation costs for the installation.

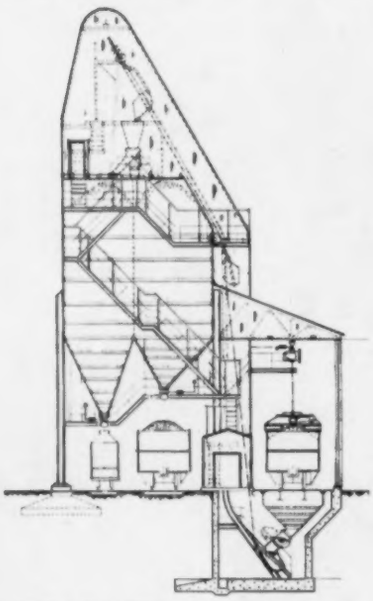
. . . AND CURRENTLY BEING INSTALLED ARE THREE MORE SWINDELL-DRESSLER ANNEALING FURNACES OF THE SAME SIZE FOR YOUNGSTOWN'S NEW TIN MILL ON ADJACENT PROPERTY



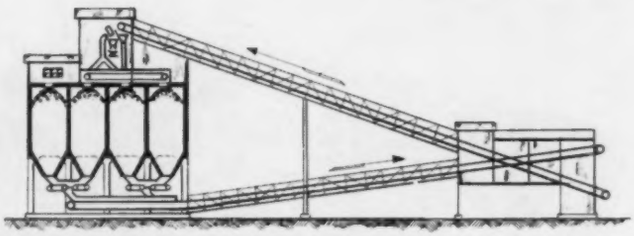
OVER 50 YEARS
R AND S COMPANY
SERVICE TO INDUSTRY

50 YEARS have brought a lot of changes

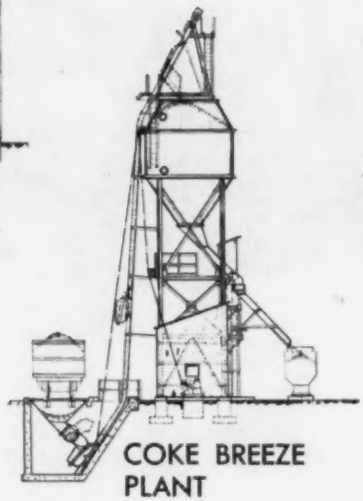
...in design of material storage and processing plants...to reduce per ton handling costs...



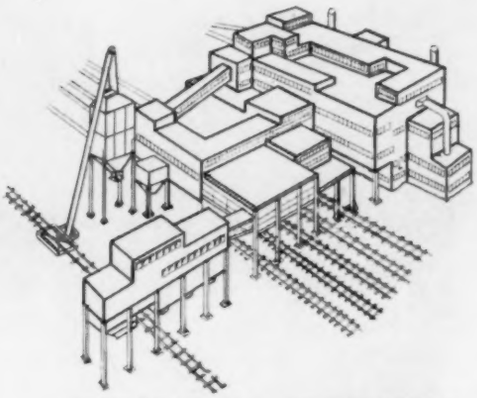
DOLOMITE STORAGE AND SERVICE PLANT



MIXING AND STORAGE PLANT



COKE BREEZE PLANT



PREPARATION—PROCESSING PLANT

ROBERTS and SCHAEFER COMPANY

Subsidiary of Thompson-Starrett Company, Inc.

ENGINEERS AND CONTRACTORS

130 North Wells Street, Chicago 6, Illinois

New York 19, N. Y.—254 West 54th Street
Pittsburgh 22, Pa.—1315 Oliver Building
Huntington 9, W. Va.—P. O. Box 570
Hibbing, Minn.—P. O. Box 675

ENGINEERED FOR ECONOMY

All National rolls are carefully engineered to exact specifications to give you the longest possible service life in your stands . . . which means a savings in less down time and fewer roll replacements.

The careful engineering is, of course, followed by production of the roll to highest metallurgical standards.

Specify National rolls and see for yourself.

THE NATIONAL ROLL & FOUNDRY CO.

(A Wholly Owned Subsidiary of General Steel Castings Corporation)

Avonmore (Westmoreland County) Pennsylvania

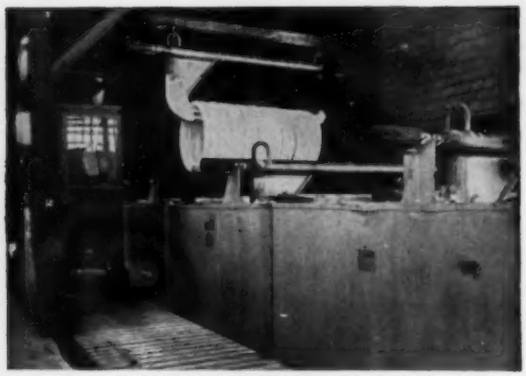
Specialists in Iron, Alloy Iron and Steel Rolls, Carbon, Alloy and Manganese Steel Castings

NO PICKLING PROBLEM Too Large or Too Small

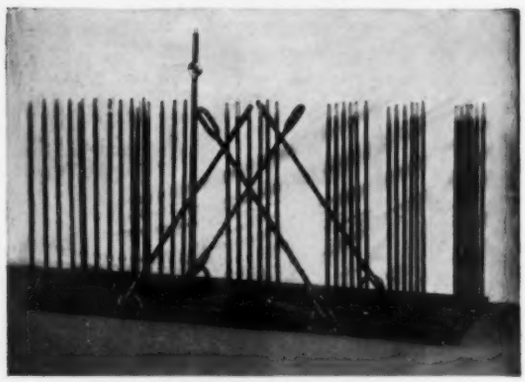
WELDCO Specialists Handle Them All!

IN HUNDREDS OF PLANTS, you'll find Weldco equipment all along the pickling line. For Weldco products are made of corrosion-resisting, hot rolled metals, that withstand attack from hot acids and other pickling solutions. They are strong yet light-weight, wear-resistant, durable, and long-lasting. You get all these advantages when you specify Weldco hooks, mechanical picklers, crates, baskets, racks, chain, steam jets, and accessories.

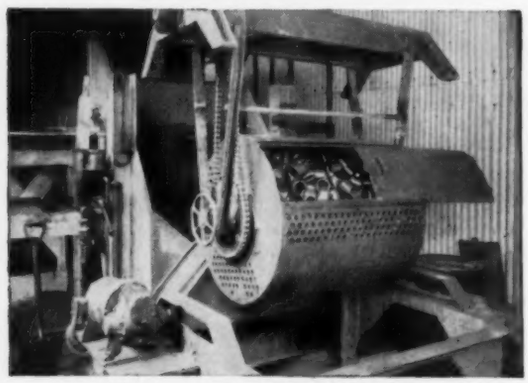
Weldco offers a complete, well-designed line of pickling equipment . . . plus the services of our experienced staff. Let Weldco engineers take care of all your pickling needs. For any problem, large or small, they have the practical, cost-cutting answer.



Weldco Pickling Hooks



Weldco Sheet Pickling Crate



Weldco Mechanical Drum Pickler

Weldco Monel Chain

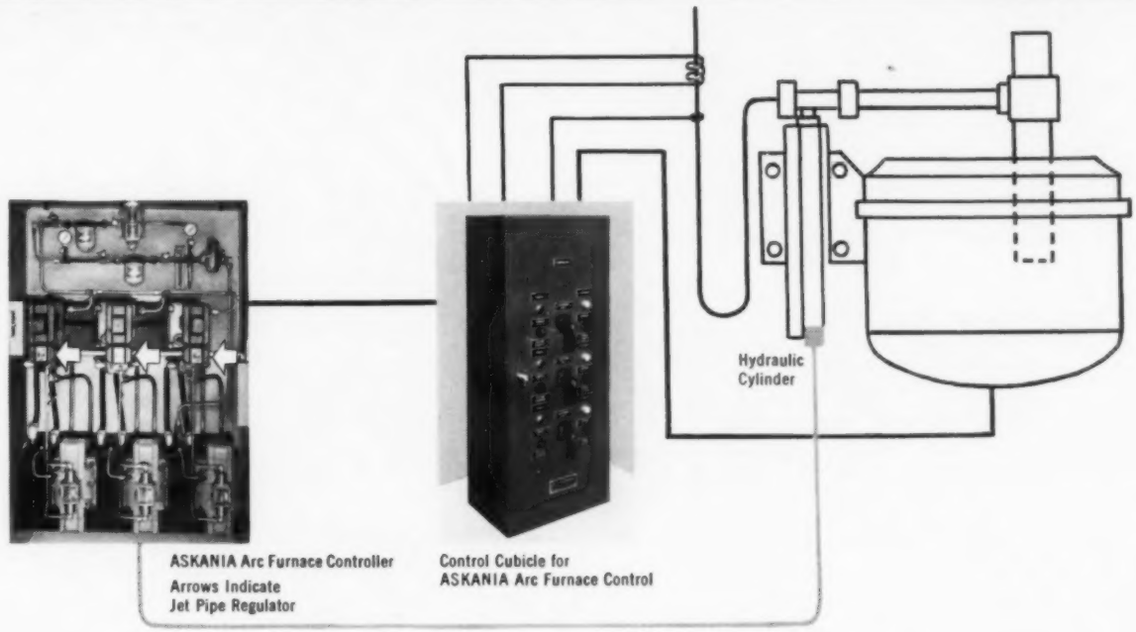
THE YOUNGSTOWN WELDING & ENGINEERING COMPANY

3712 OAKWOOD AVE. • YOUNGSTOWN 9, OHIO

ASKANIA STEEL MILL CONTROL NEWS

Automatic Controls for
COMBUSTION • PRESSURE • FLOW •
STRIP EDGE POSITION • STRIP THICKNESS

ASKANIA JET PIPE FOR DEPENDABLE CONTROL


Hydraulic Cylinder
ASKANIA Arc Furnace Controller
Arrows Indicate Jet Pipe Regulator
Control Cubicle for ASKANIA Arc Furnace Control

ASKANIA Arc Furnace Control for Faster, More Accurate, More Dependable Control of Electrodes

With ASKANIA Arc Furnace Control voltage and current signal measurements are converted directly into electrode movement through the mill-proven ASKANIA Jet Pipe Relay...*to correct any imbalance with the speed and stability of proportional speed floating control.*

Electrically, the ASKANIA Arc Furnace Control balances arc current and voltage to maintain preset power input as determined by the operator.

CONTROL ADVANTAGES

1 • *FAST*—Takes full advantage of non-compressible hydraulic fluid to accelerate or decelerate heavy loads—through zero.

2 • *ACCURATE*—High force inertia ratio of hydraulic motor (piston) *permits high performance without overshooting.*

3 • *DEPENDABLE*—Proven ASKANIA design reduces number of moving parts. Self-lubricating, it may be operated in most unfavorable atmospheric and temperature conditions *without expensive and space consuming protective shelters.*

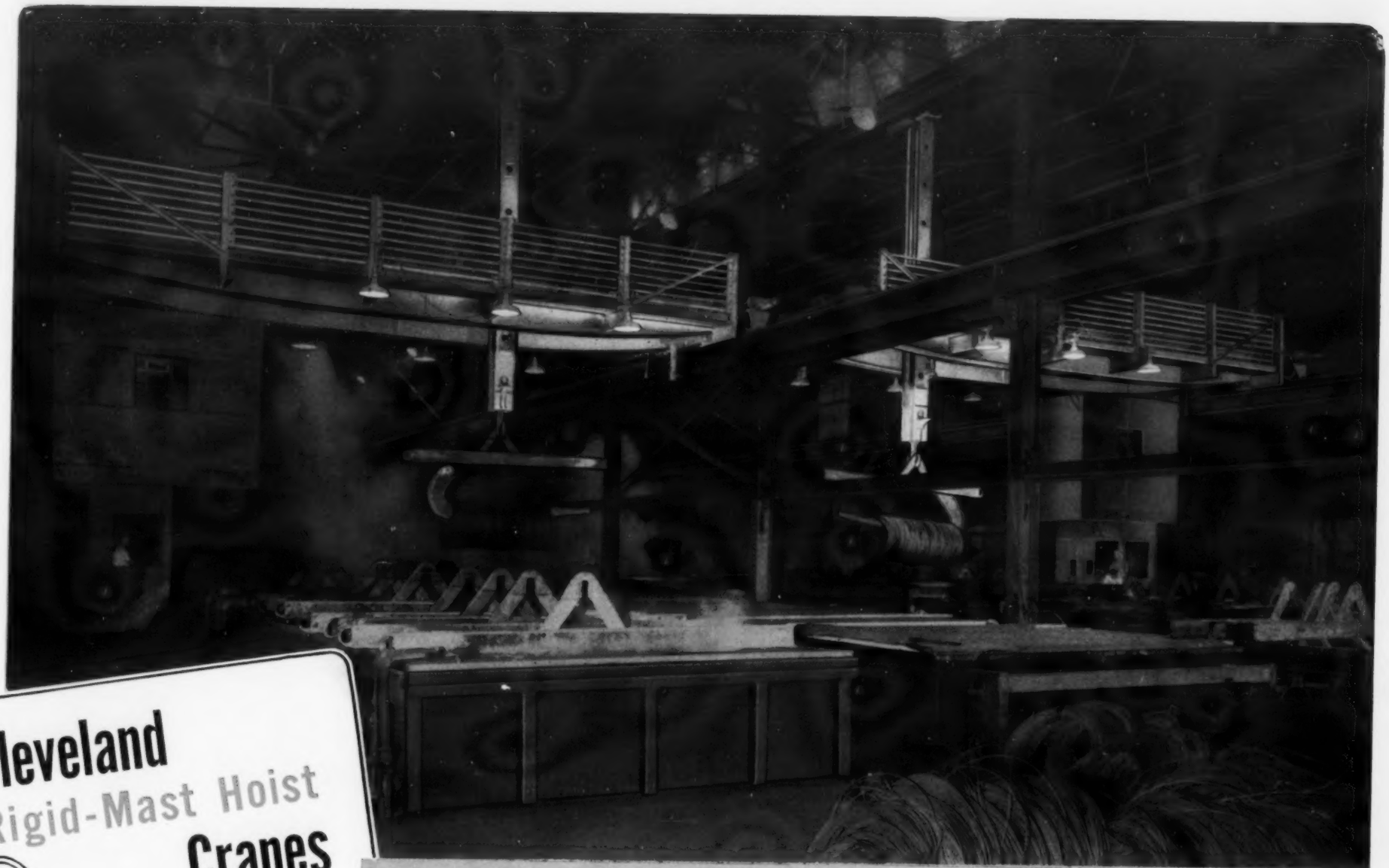
4 • *EASILY, INEXPENSIVELY MAINTAINED*—The force balance system contains only one moving part in the regulator (the Jet-Pipe Relay). Even after periodic inspection is made factory calibration is easily maintained after reassembly.

5 • *PEAK PERFORMANCE*—Advanced signal system reduces mass and consequently inertia to further improve performance.

New Descriptive Bulletin Provides Complete Information

The new ASKANIA REGULATOR Bulletin #33.2 fully describes the ASKANIA Arc Furnace Control...what it is...how it works...where it is applied...how it is maintained...the advantages it brings to arc furnace operation. Write for your copy to Askania Regulator Company, 246 E. Ontario Street, Chicago 11, Illinois.

ASKANIA REGULATOR COMPANY
"CONTROLS FOR INDUSTRY"
HYDRAULIC, ELECTRONIC CONTROLS & SERVOS, GENERAL SYSTEMS,
ENGINEERING & COMPUTER SERVICE, VALVE ACTUATORS & CYLINDERS
A SUBSIDIARY OF GPE



Cleveland
Rigid-Mast Hoist
Cranes

CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

5031 EAST 289th ST.
WICKLIFFE, OHIO

Crops and Shorts

ELECTIONS are again with us, and the press and the air will not let us forget it between now and November 6th. The mid-August weeks, when political conventions pre-empted press, radio and television, gave us enough oratory to last a long time, but there'll be lots more to endure.

▲

THE Democrats at Chicago gave a more interesting TV show than did the Republicans at San Francisco, where everything was calm and dignified. There seemed to be less "a-man-who," "point-with-pride," and "view-with-alarm" in the speeches of both parties. Republican speeches seemed quieter than those of the Democrats. Both had the exaggeration that is so much a part of politics.

▲

SOMEONE who had a hand in writing Democratic convention speeches was hipped on alliteration: "attitudes for action and platitudes for program" . . . "Benson, below parity and bankruptcy" . . . "barons of big business" . . . "giveaways, grab and greed" . . . "party of privilege and pillage" . . . "take-home pay and keep-home income" . . . "giveaway and spillway" . . . etc.

One newsman, commenting on the Democratic keynote speech, reported: "The Democrats attacked the Republicans with the jaw-bone of an ass."

▲

INCIDENTALLY, Chicago hotels, restaurants, bars and stores report that the Democrats spent money much more freely this year than they did in 1952.

Just shows what a Republican administrative term does for everyone.

▲

THE important thing is to get out the vote in November. Don't let a single acquaintance pass up his chance to exercise this privilege.

▲

RAPID amortization of new expansion projects in the steel industry (which many are convinced was the bait dangled for quick settlement of the strike) seems to be bogged down in confusion at the moment. There are different opinions as to what should be called important items for defense requirements. Apparently, new goals of expansion must be mapped out—which will probably take until after the November election.

A friend of epicurean tendencies reports a new drink—a Reno cocktail—which he says is marriage-on-the-rocks.

▲

WITH October 7-13 Fire Prevention Week, we might consider that there are more than 750,000 building fires in the United States each year, and that smoking and matches are the principal offenders. Other major causes are electrical, defective heating equipment, rubbish, lightning, flammable liquids, defective flues, and open lights, flames and sparks.

▲

THE Internal Revenue Service says the number of individuals reporting gross incomes of $1,000,000 or more dwindles each year. From 219 in 1950, the group shrunk to 145 in 1953. Looks as though the class might vanish before we can make it.

▲

DESPITE all we read about dangers of atomic war, a survey indicates that 43 per cent of the people worry about finances and wages, 30 per cent about personal problems, 24 per cent about health, and only 8 per cent about world problems, war, atomic bombing, etc.

▲

A recent survey shows that one woman in three has crooked stocking seams. The result is being checked daily by three out of four men.

▲

THE Value Line Investment Survey says that record levels of expenditures for new plants and equipment have swelled order backlogs of machinery builders to insure high level output well into 1957.

▲

THERE is a surprising amount of research under way on containers made wholly or partially of fiber, paper, etc. As the price of tin plate continues to rise, such products will come into the picture more and more—and of course, there's aluminum waiting only for steel prices to catch up.

▲

HERE'S food for thought: During the period 1939-1955, hourly earnings of factory workers almost tripled, while output per man-hour in manufacturing rose about 30 per cent. As a result, prices of products turned out by industrial workers doubled. A quadrupling of the money supply made it possible to handle the increased output of industry at these higher prices. Otherwise, many products would have been priced out of the market.

This inflation has already cut purchasing power of the dollar in half during the 1939-1955 period. If inflation of the money supply is resumed for any reason, the value of the consumers' savings will continue to decline.

All this takes some of the rosy glow out of retirement dreams.

▲

LEST you forget—see you at the Iron and Steel Exposition in Cleveland, September 25, 26, 27, and 28.

ENGINEERING REPORTS:

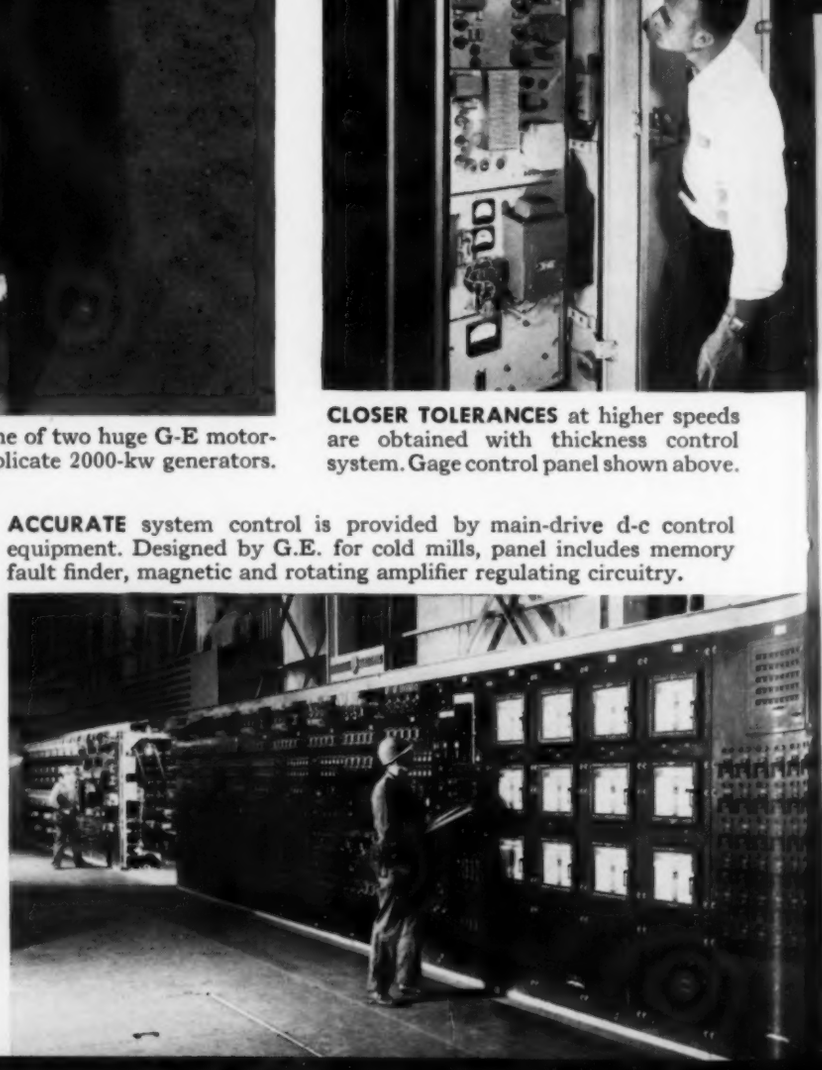
SUPPLYING POWER for stands 3 and 5, and tension reel, one of two huge G-E motor-generator sets has 15,000-hp synchronous motor and six duplicate 2000-kw generators.

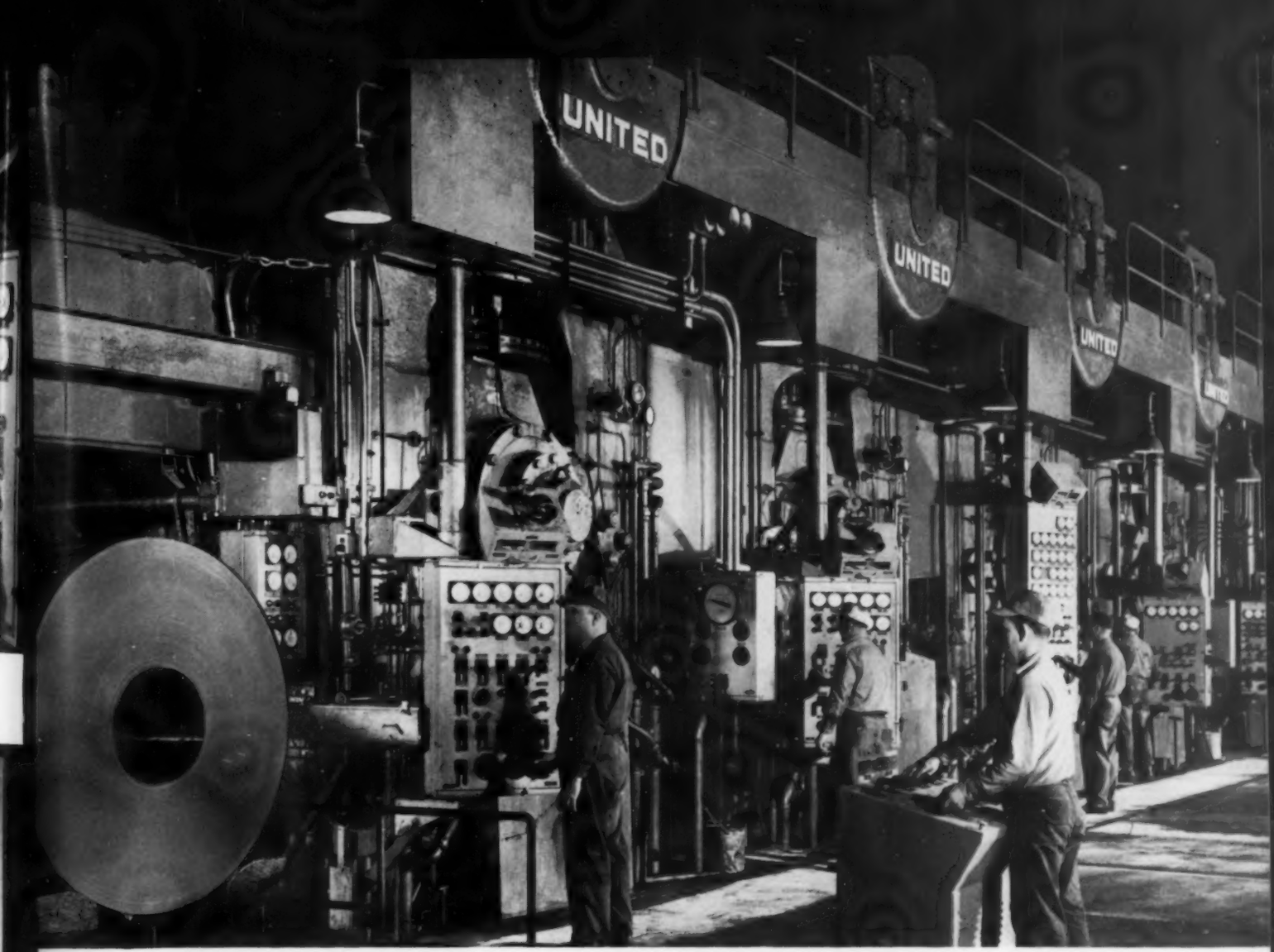
AUTOMATIC THICKNESS CONTROL system includes stand 1 X-ray indicator (left), X-ray gage (center). Operator's control cabinet is shown at right.

CLOSER TOLERANCES at higher speeds are obtained with thickness control system. Gage control panel shown above.

FAST acceleration, balanced speed regulation are obtained using specially designed, low inertia, d-c drive motors, designed to fit mill's rigid space requirements.

ACCURATE system control is provided by main-drive d-c control equipment. Designed by G.E. for cold mills, panel includes memory fault finder, magnetic and rotating amplifier regulating circuitry.





CHIEF OPERATOR'S control is located at stand 3, speed control at stand 5, on new 5-stand tandem cold strip mill.

At Weirton Steel: 28,000 hp Drives World's Most Powerful Cold Strip Mill

General Electric X-ray controlled cold mill drive system is world's fastest

National Steel Corporation's Division, Weirton Steel Company, Weirton, West Virginia, recently started up their new 5-stand tandem cold mill with a General Electric d-c drive system containing the world's greatest concentration of cold mill drive horsepower. With the new General Electric automatic X-ray gage control system, Weirton Steel Company's cold mill is another significant example of automatic production providing higher quality steel, with closer tolerances, at higher rolling speeds.

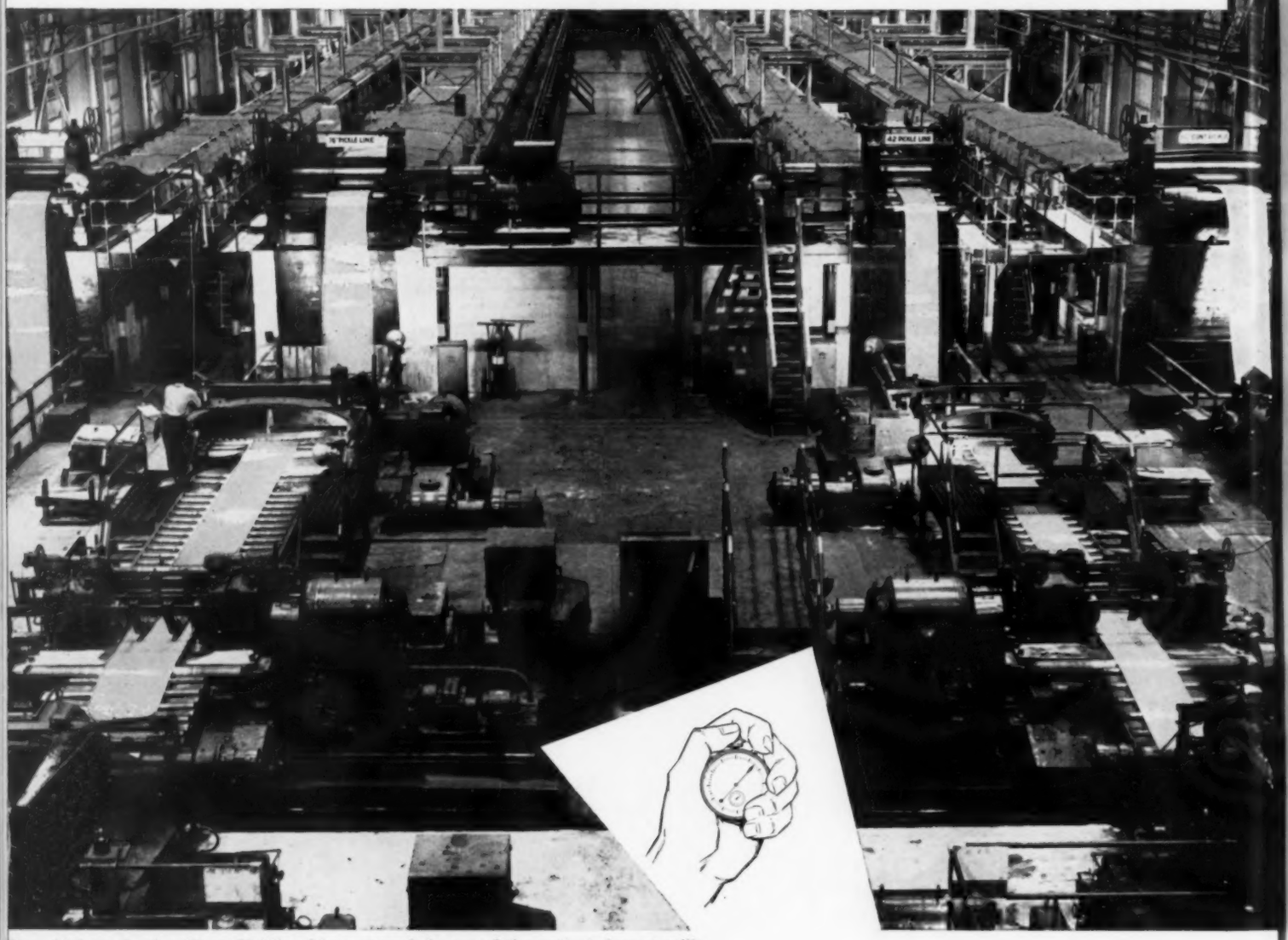
THE AUTOMATIC GAGE control system, one of the newest General Electric developments for the steel industry, has two basic elements: (1) a course regulating system to correct errors by means of the stand 1 screwdown motors, with the X-ray gage measuring stand 1 steel thickness; and (2) a vernier system controlling stand 5 drive motor speed, with the X-ray gage measuring finished strip thickness. Some of the highlights of the drive and control system are shown on these pages.

FROM INITIAL PLANNING, General Electric engineers worked closely with Weirton personnel and the United Engineering and Foundry Co. to help design, install and start up this engineered system that helps Weirton meet increased steel production requirements. Get complete information on the latest General Electric equipment and methods from your Apparatus Sales Representative at the nearest General Electric Apparatus Sales Office, early in your planning. 659-113

Engineered Electrical Systems for the Steel Industry

GENERAL ELECTRIC

From Wean Pickling Lines



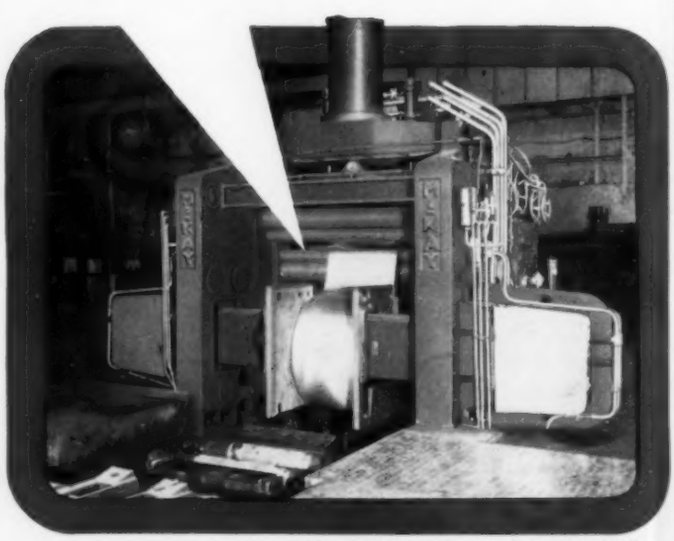
Four high production Wean Pickling Lines at work in one of the nation's largest mills.

....the finest product at record speeds

Wean Pickling Lines are setting production records wherever they are installed. BUT, more important to steel producers is the excellence of pickled product these lines are turning out—even at their fastest speeds.

Part of the story is the double breaker processing uncoiler, right, that properly prepares the strip for rapid and uniform pickling at high speeds. Wean lines are engineered to give producers installations which provide the ultimate in automation and high speed operation.

When next you're in the market for pickling equipment be certain to see a Wean line in operation. We're sure you'll be convinced Wean engineered lines are what you need.



No modern pickling line should be without a McKay Processing Uncoiler to prepare the strip for high speed pickling.

10066

The WEAN ENGINEERING CO., INC. WARREN, OHIO

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In This Issue

Patent Reviews — By Melvin Nord, Patent Attorney, Detroit, Mich..... 23
Crops and Shorts..... 69
Ideal Maintenance Machine Shop Facilities — By W. J. Pearson, Machine Tool Engineer, Bethlehem Steel Co., Bethlehem, Pa..... 75
Expansion of Industrial Water Facilities at Sparrows Point — By Frank R. Hauser, Water Engineer, Bethlehem Steel Co., Sparrows Point, Md.. 81
Learning to Live With Your River — By Harold F. Miller, Assistant General Manager, Bethlehem Steel Co., Bethlehem, Pa..... 86
Are You Getting Good Returns From Your Ventilating Investment? — By Dr. Allen D. Brandt, Chief Industrial Hygiene Engineer, Bethlehem Steel Co., Bethlehem, Pa..... 92
Productive and Preventive Maintenance of Finishing Mills — By William C. Whitmore, Supervisor Electrical Maintenance, Alan Wood Steel Co., Conshohocken, Pa..... 101
Central Maintenance Operations and Control at Fairless Works — By Roy L. Leventry, Division Superintendent, Maintenance and Utilities, Fairless Works, United States Steel Corp., Fairless Hills, Pa..... 110
A New Insulation System for Auxiliary Mill Motors — By M. W. Kitzmiller, Manager, Medium D-c Motor and Generator Product Engineering, D-c Motor and Generator Dept., General Electric Co., Erie, Pa..... 119
Maintenance Viewpoints — By J. Serenka, Master Mechanic, Strip and Sheet Division, Pittsburgh Works, Jones and Laughlin Steel Corp., Pittsburgh, Pa..... 122
Welding and Cutting in Steel Mill Maintenance — By R. L. Deily, Steel Mill Representative, Air Reduction Sales Co., New York, N. Y..... 126
Selection and Use of Roll Neck Bearings — By K. E. McHenry, Assistant to Superintendent, Mechanical Dept., Bethlehem Steel Co., Lackawanna, N. Y..... 130
The Mechanics of Lubrication — By Charles L. Pope, Lubrication Engineer Eastman Kodak Co., Rochester, N. Y..... 133
A Practical Solution to a Fuel and Lubrication Problem — By C. R. Burton, Superintendent of Maintenance, Hibbing-Chisholm District, Oliver Iron Mining Division, United States Steel Corp., Hibbing, Minn.... 135
Increasing Capacity of Ladle Cranes — By Eugene Whitaker, Chief Mechanical Engineer, Granite City Steel Co., Granite City, Ill..... 140
Remote Control of Equipment Over Existing Power Lines — By John W. Bauer, Jr., Sales Engineer, Femco, Inc., Irwin, Pa..... 148
Program — 1956 AISE Annual Convention and Iron and Steel Exposition.... 152
Abstracts of Technical Papers at AISE Annual Convention..... 157
The Installation of, and Split Wind Blowing With, Topping Turboblowers for Blast Furnaces — By E. W. Austermiller, Chief Engineer, and W. A. Smith, Superintendent, Power and Fuel Dept., National Tube Division, United States Steel Corp., McKeesport, Pa..... 173
The Brains and Muscles of an Ore Bridge — By H. A. Zollinger, General Mill Section, Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa..... 181
Current AISE District Section Meeting Notices..... 189
Maintenance and Development of the Small Tonnage Steel Plant — By R. D. Bradley, Chief Engineer, and D. W. Petty, Jr., Superintendent, Electrical and Mechanical Maintenance, Bethlehem Pacific Coast Steel Corp., San Francisco, Calif..... 190
Ore Unloading Facilities at South Chicago — By W. B. McLean, Structural Engineer, Engineering Works Division, Dravo Corp., Pittsburgh, Pa. 197
Washington Steel Starts New 52 In. Sendzimir Mill..... 205
Date-line Diary..... 217
Industry News..... 233
Personnel News..... 265
Equipment News..... 297
Book Reviews..... 318
Index to Advertisers..... 347

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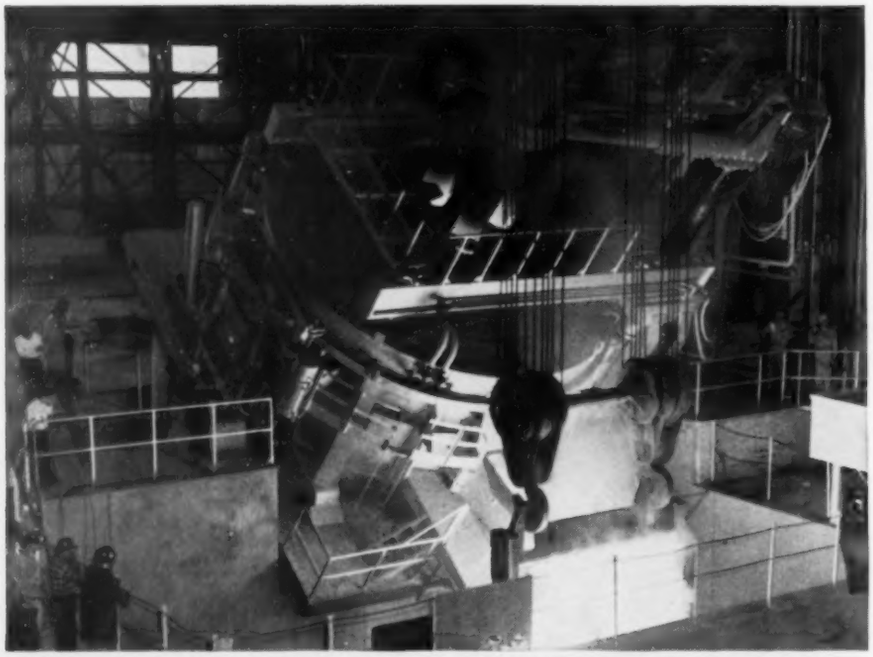

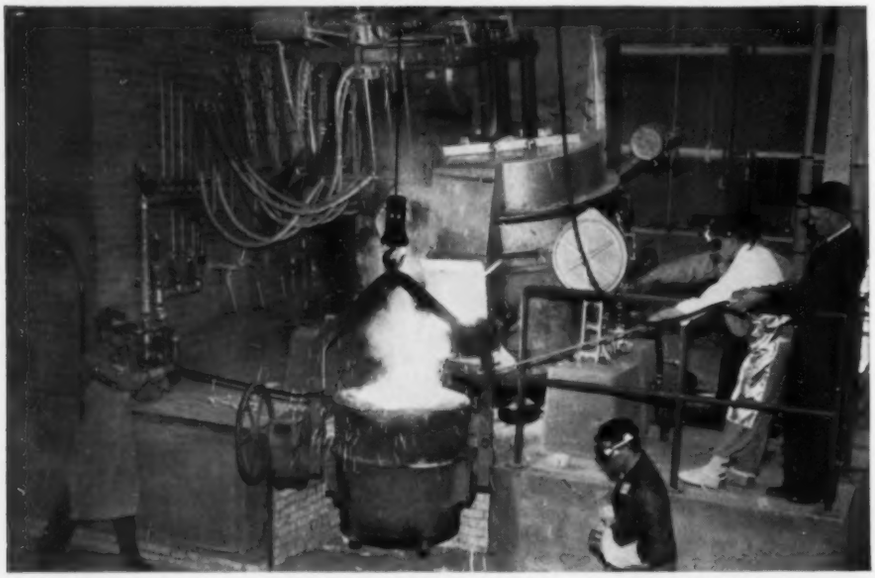

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WHEN YOU MELT... *Lectromelt*

IDEAL MAINTENANCE MACHINE SHOP FACILITIES

By W. J. PEARSON
Machine Tool Engineer
Bethlehem Steel Co.
Bethlehem, Pa.

▲ FROM time immemorial people have dreamed and talked of ideals. Volumes have been written on thousands of subjects setting forth theories for obtaining perfection. The opportunity to set forth one's views on what the ideal maintenance machine shop should be for an integrated steel plant has rarely been offered and the possibility of putting them into practice may occur to some person interested in this phase of the steelmaking industry.

Most individuals have no doubt been more concerned with the necessity of finding ways and means of improving and expanding existing facilities, with the foreboding shadow cast by interference with other shops, railroad tracks, necessity to utilize buildings designed for other uses, plus the limits of operating budgets.

As there are no limitations existing in a hypothetical shop, it is hoped that this paper may serve as a guide to those individuals engaged in finding possible solutions to practical situations.

Machine shops should be considered as such; therefore such facilities as forge shops, fabricating and welding shops, heat treating departments, specialty repair or manufacturing shops are eliminated from this discourse, though each offers the possibility of discussion by itself and it is recognized that such shops are equally important and essential.

Maintenance requirements of an integrated steel plant of 450,000 net tons per month have been used for a basis to determine the necesary equipment. Such a plant would include coke ovens, blast furnaces, open hearths, blooming, structural, bar, hot and cold strip mills, power facilities and some of the usual specialty mills or manufacturing units involving such operations as turning, boring, drilling, planing, milling, grinding, threading, layout, assembly and testing, as well as specialized operations of which gear cutting is a common example.

It is estimated that approximately 40,000 direct man-hours per month would be necessary to handle the maintenance work of this integrated steel plant and as machine tools are the means by which most jobs are accomplished, they will be considered first, and the building put around them later.

Turning as done in an engine or turret lathe, accounts for 25 to 30 per cent of the shop work which makes such machines of prime importance. Work of this type, running from simple jobs as pins to more arduous and complicated components as shafts, pinions and spindles, requires a variety of sizes to accommodate the wide scope. It is often stated, that if a machine is big enough to do the large job it is capable of handling the small job; the statement is true within limits, but a 60-in. lathe looks pretty silly making a ½-inch bolt, besides being rather uneconomical.

No less than two large lathes should be considered; one of at least 72-in. swing, the other 54-in. swing, and

Shop men, in their supervision, must be trained in the proper use of today's cutting materials as permitted by modern tools . . . . only with a complete understanding of machine tool possibilities can an ideal shop, or any shop, be selected and realize an economic return on the large investment required.

both of them capable of being raised when the jobs demand increased clearances. Center distance for each should be no less than 30 ft. The auxiliary equipment and other specifications for each machine are listed as follows:

Two carriages each with four-way traverse.
One taper attachment suitable for use on either carriage.
One pair roller rests to take up to 24-in.
One pair roller rests to take up to 8 or 10-in.
One pair plain jaw rests to take up to 48-in.
One pair plain jaw rests to take up to 30-in.
Interchangeable tailstock quill with anti-friction spindle.
Feed gearing to be suitable for heavy leads and odd pitch threads.
Power feed to the compounds.
Tailstock designed to be fed by carriage.
Headstock designed for 75 to 100 hp and speed range suitable for carbide tooling.

Another set of engine lathes is necesary in the 36-in. swing category; one with a center distance of between 20 to 25-ft, and the other no more than 12-ft, the longer of the two having its length determined by the line shafting of the mill tables. Auxiliary equipment would be similar to that described for the larger lathes with the obvious reduction in size of steady rests and only one carriage on the short machine. Power requirements would be reduced, but to not less than 50 hp.

The four lathes would comprise the heavy turning group for handling line shafts, table rolls, mill pinions, spindles, car axles, bell rods, turbine rotors, fans, crane drums, shaft assemblies of the larger type, crusher rolls, hydraulic pistons and with proper tooling, the boring of cylinders, peels and deep hole drilling.

Getting into a smaller group of work it is felt that three 25-in. swing lathes are necessary. One being at least 20-ft and the other two 12-ft between centers. These machines should, if possible, be similar, providing some interchangeability of such tooling as steady rests, fixtures mounted on the carriage wings and should at least have the same spindle nose type to allow chuck and spindle mounted fixture interchange. Longitudinal rapid traverse should be supplied and the headstocks should be capable of handling 50 hp. One of the short machines would be equipped with a duplicator of the type that does not interfere with easy changeover to standard lathe operation.

Three lathes with 18-in. swing and two of 14-in. swing are also necessary, all with six-ft centers, except one 18-in. which should have 10-ft centers. Anti-friction tailstocks should be provided for all machines, with taper attachments on one of each size and all with standard spindle noses. Headstocks should be good for 25 hp.

Comprising the small engine lathe group, the foregoing eight units would handle the multitude of smaller shafting, axles, rods of all descriptions, bearings, mandrels, arbors, screws, long bolts, pins, integral shaft pinions and some gears.

In a separate unit, there should be two 16-in. lathes of the so-called "tool-room" type, one of which should be equipped with "the works". Both should be supplied with taper attachments and coolant pumps, chip pans, and 15 hp motors. One lathe need not be over 6-ft centers, while the other would be 8 or 10-ft. Some shops dispense with such equipment; however, it has been experienced that there are times when special cutters of either the milling machine variety or reamers of odd size or shape must be made in a hurry and facilities of this type become indispensable. In addition, there are the innumerable items that are always being made that require the best of equipment to produce the called-for accuracy.

With some dozen-odd units producing turned work, either from bar stock or forgings, the matter of preparation of components prior to these machines must be thought of. Observations have been made that in general the cutting to length and centering, if and when required, is performed on the lathe. Hacksaws and cold saws are of course available and each has its place of application. Centering machines are also available for some types of work, but are not too universal in application.

For this shop, two automatic hacksaws are necessary, both with tables for automatic feed when multiple parts are required. These tables should be of the most rugged type available even if they have to be made special. The same applies to the stops, as abuse in this direction is almost impossible to avoid.

Centering is not simple, particularly on forgings with several diameters and of any appreciable length. A combination gaging, checking and centering machine is the answer, and when found with the proper characteristics it will have a blue-ribbon spot in this shop. Until such a time comes to pass, a conventional unit will have to do with a capacity of 6-in. diam and at least 12-ft in length.

Changes in design gradually produce changes in practice or methods. To economically produce close tolerances with specified fine finishes, which today are becoming more common in steel plants, the lathe is a poor pace setter. Grinding is practically a must for anti-friction bearing seats, for removing distortion from heat treated components, sizing hard welded surfaces and producing fine surface finishes.

Cylindrical grinders there will be in this shop—one 24-in. by 240-in. centers, one 16-in by 144-in., and two 14-in. by 72-in., one of which would be the universal type. When properly used, these machines will eliminate a considerable amount of time spent polishing or grinding with a makeshift rig on the lathes. Tolerances and finish will be met and improved life of the components in the mill realized.

Turning to an oft-neglected and misused piece of equipment, there are six turret lathes in this layout, namely:

One 9-in. bar capacity.
One 4½-in. bar capacity.
One 22-in. chuck capacity.
One 2½-in. bar capacity.
Two No. 5 ram type.

The first four units are all to be arranged with cross-sliding hex turrets and with four-way rapid traverse to the square turret. While three of the units are designated as bar machines, they should be equipped with chucks so that they may be used either way. In maintenance operations, the jobs are too varied to have units of this type too specialized.

The larger machines are required for the production

of larger bolts, threaded bars where turning and undercutting are required, production of parts such as shaft pinions made from forged bars of several multiples in length, couplings, sleeves, liners, bearings, gears, wheels, sheaves, etc. The small ram type and to some extent the smaller of the saddle type units will find plenty of use in the production of those myriad bolts, threaded sleeves, small bearings, pins, as well as others too numerous to mention.

Getting into a different class of work, but still providing means for turning, boring and such, there is need for at least five vertical boring mills. Starting with the largest and working down, there are one 20-ft, one 10-ft, one 6-ft and two 42-in mills.

The three smaller machines should have side heads and both turret and ram heads on the rail. The larger machines would have only right and left rams on the rail with a special traveling head bar piloted in the table and fed through a removable take-off feed bracket on the rail.

Large gears, sheaves, bearings, chocks, couplings, valves, tires, bells, hoppers, cylinders, rings, certain types of housings, and seals all consume a considerable amount of unit time and are far better worked in the flat down on the table position than strapped on a lathe face plate. The large mill will not be busy too much of the time, but when it is needed there is a great relief in knowing it is available.

Horizontal boring mills are generally too few in number, besides lacking the range to properly handle the large jobs, thus causing unnecessary delays from repeated set-ups. Because of the variety of cutting in several different planes, such as occur in a mill housing, drive gear housing or a shear frame, it is a necessity to take advantage of the most universal equipment available; namely, a draw-cut shaper-boring machine. The physical requirements of such a machine should be based on the dimensions of the largest mill housing that may eventually be involved.

Additional mills would be of more conventional type; such as a 7-in. floor type with 14-ft column travel and 10-ft vertical travel equipped with underarm support, a 6-in. table type also equipped with underarm support and with a table of approximately 72-in. by 120-in., a small 6-in. table type and a 4-in. table type. All table type units should be equipped with automatic positioning and precision end measures.

Due to the heavy investment in such large machines, it is imperative that every effort be made to see that the auxiliary equipment such as angular milling and drilling heads, rotary tables, slotting or cross-shaping attachments, high speed milling heads, threading attachments, knees, blocks, bars, cutter heads and cutting tools be available to reduce the idle time caused by improvisation.

Leaving the large machinery for a moment, to get back to one of the work horse centers of the shop, consider drilling machinery. With the possible exception of the lathe, there is no other machine used more and abused more than a drill. Nearly everyone getting inside a shop for their first job makes friends with what is generally the oldest machine present, a clunker of a radial drill. Used properly, a drill can be a very efficient and accurate tool, serving as boring, threading, milling and broaching machine, besides putting holes where they may or may not belong.

Some five radial drills should be available in a shop of this size ranging as follows:

One 8-ft arm, 19-in. column, raised to 8-ft under the arm.
Two 6-ft arm, 19-in. column.
Two 4-ft arm, 15-in. column.
In addition there should be:
Two 24-in. round column upright drills.
Two 14-in. sensitive drills.
Four 12-in. or 14-in bench drills.
One 24-in. upright drill arranged with a compound table to make what may be called a layout drill, or possibly a medium sized jig-borer.

This latter unit might be considered a luxury unless the mill equipment is replete with hydraulic valves and control, in which case it can hardly be dispensed with.

The larger 8-ft and one of the 6-ft radials should be so arranged that a pit is available adjacent to the bed, thus enabling larger work than normal to be handled easily. To accommodate end drilling of shafts, one pit should be provided with a fifteen-ft pipe about two ft in diam sunk at one edge near the machine base. The other 6-ft radial should be normally set on a slab, held down by clamps, and equipped with bails so that it can be conveniently carried by crane to the assembly area when the jobs demand such service.

Compared with a 4 or 5-in. horizontal mill, an 8-ft arm radial drill is relatively inexpensive; however, if the same attention would be paid to tooling the radial as is normally given a mill, the increase in efficiency would be astounding. More will be said along this line later.

The old faithful of the machine shop for years past has been the planer and in a smaller size the shaper. Slow and steady, there have probably been more "Rube Goldbergs" made by planer operators to relieve boring existence than for all the other tools in the shop. Since the period of World War II, when the desire to see chips fly caused a minor revolution in flat surface preparation, there have been two very rabid schools develop, one advocating milling and the other defending planing.

It is felt that planers will be with us for years to come, particularly in maintenance shops. Far from being slow, the modern planer is a long cry from what most shops are forced to endure. Precedent, formed from long usage of slow machines has no doubt been the reason for keeping progress in development of this type of machine to a crawl. When the user demands and competition forces improvement, then shops will benefit. Cross-cutting and two-way cutting at full carbide speeds are requirements for the shop. Probably no other machine offers such a means of low cost improvisation as a planer, which counts when a typical "once in fifty years" repair job comes along.

A 12-ft by 12-ft by 25-ft double housing planer tops the list, then a 6-ft openside with 20-ft stroke and arranged for an auxiliary outboard traveling support, a 4-ft openside with 12-ft stroke and a 3-ft openside with 8 or 10-ft stroke.

For the smaller units in this class of machine, or as

they are better known—shapers, there should be no less than four. One should be of the traveling table or shaper-planer type, arranged with a duplicator on the rail head, and it should have a stroke of no less than 36-in. and also be arranged with a side-head. The other three can be plain shapers of the more conventional traveling ram type and 24-in. stroke.

The planers are necessary for repair work on bed plates, mill shoes, table girders, shear gage guides, shear blades, long key-ways, both internal and external, and motor bases. The shaper-planer with the duplicator is about the handiest machine there is for shear blades, mill guides, slippers and any other repeat job having curved or intricate machined shapes. Above all, the tool cost is kept to a minimum with this type of unit.

Somewhat akin to the planer is another member of the family, the slotter. It is sometimes felt, that if no other way can be found to do a job, it winds up somehow on the slotter. By the same token of precedent mentioned before, there are dozens of jobs on slotters which have no right being there. Nevertheless, this shop has two of them; one 48-in. and one 20-in.

Keyways and splines, cross slots, odd shaped holes, and, in a pinch, gears, fall to the lot of these machines, which like modern planers are capable of doing far more than is usually the case.

The regular run of internal keyways is probably best accommodated by the use of a 4-in. by 36-in keyseater. This machine is capable of handling straight or taper keyways and with the aid of an indexing table provides the additional means of accurately locating multiple grooves or splines.

Milling has already been briefly touched on in connection with horizontal boring mills and with reference to competition offered planers. There are several types of jobs where there is no controversy and milling is the only answer. Take for instance, a flat shear blade, some 6 to 8 in. wide by 1½ in. thick and 4 or 5 ft long to be prepared for heat treatment. The surfaces are from ⅛ to ¼ in. over size all around, offering ideal milling possibilities so there is hardly an alternate method of stock removal that would be competitive. Special gears, splined shafts, keyways in shafts, jig and fixture components, odd shaped machine or auxiliary mill parts, tee-slots, bearing brasses, as well as hundreds of other similar parts require milling and economically should not be loaded on more expensive units—horizontal mills, for instance.

It is safe to say that some 80 to 85 per cent of the shafts made for maintenance purposes will have at least one keyway, if not more, with an average of probably four. To accurately cut these keyways there is sufficient justification for a special purpose miller of a capacity to handle at least a 12-in. shaft and the accepted standard width and depth for such. The length of travel would be determined by the design of mill parts to be handled, and would be no less than 8-ft. This type of machine of course is equipped with both horizontal and vertical spindles as well as direct reading scales and verniers to eliminate wasted time in layout. For further reducing idle time, a suitable index head should be used when multiple keyways are involved.

Vertical millers provide easier setup and visibility, and so are given preference, but not to the complete exclusion of plain or universal horizontal machines.

One No. 5 vertical, one No. 4 vertical and a No. 4 universal will take care of the larger size work, while a pair of No. 3's, one vertical and one plain will be adequate for the small work. In all cases this type of machine should be provided with its own complement of arbors, vises, rotary tables, quick change tool holders and other more specialized attachments to bring about maximum efficiency.

While cylindrical grinding has already been discussed, there remains the matter of surface grinding. Shear blades have a particular habit of being in constant demand, so it is necessary to provide means of handling this daily problem. A machine with no less than 25 hp for the spindle, and at least a 24-in. by 120-in. table of the horizontal spindle type is recommended.

Vertical spindle machines, due to their limitations are not recommended for maintenance work. Consider, for instance, a mill screw with a spline drive that is surface hardened and consequently warped so that proper fitting to the driving component is out of the question. Grinding is necessary and a vertical machine does not lend itself to such possible use while a horizontal spindle machine is ideal.

For the smaller runs of surface grinding, a smaller 14 x 16 x 60-in. machine is required, besides two 8 x 12 x 24-in. units.

Continually encountered in repair work are those jobs where a reasonably flat surface is required but the casting, forging or weldment from which it is made, causes excess tool wear when machined on a planer or a miller. There are also the frequent problems of surfacing a built-up area replete with all the troubles of hard welding or a manganese steel part nicely work hardened. A traveling head face grinder would be selected for several reasons; no normal cutting tool, even carbide, has a chance of survival, off-hand grinding is at best a make-shift; tool post grinders in a planer get by but contribute to abnormal wear of the machine and unfortunately most of this type of work is bulky and very awkward to handle on a traveling table machine.

Engine lathes and turret lathes account for a considerable amount of threading which in the case of the turret lathe, may or may not be done with a die-head. In a steel plant where changes and additions are almost daily occurences, a vast number of foundation bolts, threaded rods and semi-special bolts are required. These products do not belong in a lathe at any time unless a dire emergency exists.

A two-spindle threading machine to handle up to 2-in. or 2½-in. diameters and a 4-in. single spindle machine, both equipped with lead screws can be considered ample capacity for the normal needs of plant. By way of caution, it is not inferred that all bolts or standard threaded parts should be made by the maintenance machine shop as such methods described would not be competitive with the regular producers of the standard product.

Probably every steel mill in existence today has gears and plenty of them, of all types, shapes and sizes. How far to go in providing means to produce gears in a maintenance shop is a very difficult question to answer specifically. Some facilities should be available and for the ideal shop the minimum will be furnished.

For the normal spur, helical or worm gear repair job, hobbing capacity up to 72-in. diam will suffice, but as pinions break or wear out more frequently, there should be two units to handle the job. The other hobber is a 48-in. capacity machine and both should have the maximum size hole possible through the table to accommodate integral shafts or jobs where it is undesirable to remove the shafts. Sprockets and spur gears of heavy pitches require an automatic 60-in. gear cutter, which will complement the two hobbers for capacity.

On the auxiliary machinery around a mill, in control mechanisms, small integral pinions and such, there are innumerable cases where the design of the component will not allow a hob or disc type cutter to be used. For this work, a gear shaper is essential. It should be at least 36-in capacity, and supplied with a large hole through the work table to accommodate shafts.

Bevel gears that one encounters, fortunately are the straight tooth type. The spiral bevel which may be found in a reducer or special machine, had best be purchased, as the equipment that produces them is definitely special and requires knowledge for the operation that is not too often found in a steel plant.

Depending primarily on the number of line shaft driven tables in existence, two 25-in. bevel gear generators with a capacity to handle from 24-in to 36-in. diameters will suffice.

Checking equipment of a simple type, generally consisting of an accurate method of mounting the gears for determining proper center distances or backing distances in the case of bevel gears, will be found desirable as the time saved on the assembly of a job is well worthwhile.

Disassembly which normally precedes assembly requires some mechanical equipment, particularly a horizontal hydraulic forcing press, which conversely would also be used in the assembly of the repaired product. This unit should be either inclined or horizontal, to allow overhead cranes access in placing and removing work. Capacity of this press should be no less than 600-tons. A large press is awkward for the majority of press fit work, so a smaller unit of around 300-tons is necessary. For the assembly of bearing races, bushings, etc., a vertical press of 150-tons would be provided.

As expediency is generally necessary in a steel mill, many shafts are repaired by straightening, and the common method is to use a lathe, plus jacks, torches, hold-down clamps, timbers and occasionally an overhead crane. It is a safe bet that the result is a shaft that is still bent and a lathe that will not turn straight, if not sometimes a broken bed.

To prevent the possibility of the foregoing becoming standard practice in this shop, a straightening press is provided to insure the lathes being used for lathe work and the shaft getting straightened. The press should be capable of taking 18 to 20-ft in length, and cold straightening 4-in. shafts, as well as heated larger diam work within the machine range.

The assembly floor should also have the following basic tool equipment: small power hacksaw, 1½ in. capacity upright drill, ½-in. capacity bench drill, 20-in. plain shaper, floor grinder, and a portable universal drilling, reaming and boring machine. This last tool cannot be surpassed when it comes to drilling and tapping at assembly on operations normally requiring considerable inventiveness.

So far all the equipment mentioned has been for the direct production of components to be used in the maintenance of a mill with no reference to the facilities required to keep the machine shop itself operating. It is obvious that a tool repair and grinding department is essential so the following list covers the machines without going into detail.

1—Small lathe, 12 to 14-in. capacity by 3-ft centers.
1—24-in. round column upright drill.
1—14-in. sensitive drill.
4—No. 2 universal tool and cutter grinders.
2—14-in. double wheel carbide tool grinders.
1—chip breaker grinder.
1—large drill grinder.
1—small drill grinder.
1—drill web grinder.
1—reamer grinder.
1—universal milling cutter grinder.
1—automatic hob and cutter grinder.
1—hob tooth spacing checker.
1—lathe or planer tool template controlled grinder.
1—20 or 24-in. double spindle floor grinder.
1—10 or 12-in. double spindle bench grinder.
1—50-ton hydraulic arbor press.
2—hand arbor presses.

Some ninety odd tools take up a little room, as do necessary offices, tool crib, welfare facilities, walkways and the like. It was decided to make a two-bay building with the main bay housing the larger tools and the assembly area; the smaller parallel bay would be two-story construction having on the ground floor the balance of the machines, plus the crib for the dispensing of necessary tools and auxiliary equipment, and on the second floor the offices, welfare facilities, tool repair and grinding, and the apprentice department.

The main bay would be some 75-ft by 400-ft, served by two 50-ton cranes with 10-ton auxiliaries and 30-ft lift. The side bay would be 45-ft by 400-ft, served by two 10-ton cranes having 20-ft lift. Auxiliary means of handling work is provided in the form of jib cranes at those units where work runs over 25 to 30 lb.

Ample general lighting would be installed to give a work level intensity of approximately 30-ft candles and each machine or work area would have the necessary auxiliary lighting when the occasion demanded its use.

Coolant distribution and return, plus chip disposal by way of under floor piping and conveyor is provided to minimize hazards, and promote cleanliness. Each machine would have available the necessary type of filtered, temperature controlled coolant in any desired volume. Ample width aisles provide safe access to units affording additional work handling means by lift trucks and pallets or tote boxes.

As long as this shop has the word "ideal" attached to it, some "gold plating" might just as well be included, so the whole shop is air conditioned..

Paralleling the building on the side adjacent to the main bay is an overhead crane runway of 60-ft span and 30-ft clear lift, having one 25-ton crane. This area provides the storage space for parts to be processed and is not a finished spare part yard.

Railroad access tracks are provided into both ends

of the building for approximately 75-ft. Tracks also run the length of the open runway tying into the shop tracks at either end. Truck entrance to the main shop is coincident with the tracks. Running between the storage yard and clear across the two bays of the shop are two transfer tracks, each having a 25-ton capacity car, one located some 150-ft from the end of the shop given over to assembly, and the other about 100-ft from the opposite end, thus giving ample means of getting material both in and out.

The scope of this paper does not cover any discussion on the selection of supervisory personnel, manufacturing orders or stock control systems and the like, but it should be mentioned that to effect any degree of efficiency in the operation that there be planning of the jobs before they are issued to the shop. This is not meant to be routing from one machine to the other, but a systematic analysis of each and every job so that the proper tool, equipment and the like may be provided before the work is in the machine. The supervision must be trained, as well as the machine operator, in the proper use of today's cutting materials as permitted by modern tools. Only when the complete understanding of the possibilities of metal removal have been absorbed by all personnel can the ideal shop, or for that matter any other shop, realize a just return on a very sizable investment in an essential part of the integrated steel plant.

DISCUSSION

PRESENTED BY

S. C. READ, Director, Construction and Maintenance, Jones & Laughlin Steel Corp., Pittsburgh, Pa

O. J. CREPEAU, Assistant Superintendent, Mechanical Department, Inland Steel Co., Indiana Harbor Works, East Chicago, Ind.

W. J. PEARSON, Machine Tool Engineer, Bethlehem Steel Co., Bethlehem, Pa.

S. C. Read: I would like to express appreciation to Mr. Pearson for developing a yard-stick which we can apply to rating existing machine tools and facilities in a steel mill machine shop. There has been outstanding progress during recent years in steel mill expansion and it is therefore fitting to highlight the importance of having the necessary efficient machine tools for the maintenance shop.

Mr. Pearson has listed the equipment for the ideal shop and in doing this he defended the planer. I would like to support his views that a planer of modern design should be included and also emphasize the desirability of having a draw-cut machine.

Included with the ideal shop is an open crane runway adjacent to the shop for storing parts to be machined. I will ask Mr. Pearson to express his views as to also providing area adjacent to each machine for storing parts to be machined and second, his views on a program that could be established for the replacement of machines, as they become obsolete and inefficient, with equipment of the modern design.

O. J. Crepeau: The author has put this shop in an adequate building and has provided it with proper tools, storage space, tool cribs and tool repair facilities. I think he has put machine tools in his shop with enough power and size to do most jobs which might come into a maintenance shop.

Mr. Pearson mentioned one dimension on one of his large lathes which we have found to be inadequate. On this large lathe it would be well to set the minimum distance between centers at 35 ft. We have found this necessary since some of our stripper screws now measure 33-ft overall. Other than that, I think every machine shop man in the country would like to call that ideal shop his own.

W. J. Pearson: In answer to Mr. Read's first question regarding storage space adjacent to each machine, I would state that personally I am against any use of machine shop floor area for other purposes than working areas. It is realized that job preferences change and schedules cannot always be maintained, but such conditions that require jobs being set aside should be the exception rather than the rule. There should be available adequate laydown areas to serve immediate work centers, but they do not necessarily have to be adjacent to each individual machine. Ample crane capacity provides the means of getting the large jobs on and off the heavy machines and proper planning of the work provides the time schedules so that it should not be necessary to have a multitude of jobs piled up on valuable floor space.

The smaller machines present a somewhat different problem, though it is felt that with proper planning and handling facilities, not more than the average turns work need be provided for in the work area of the machine.

Once components have an operation completed, the piece should be moved to the next location as indicated by the planning sheet. When the part is completely finished, it should be taken to the storage area provided pending its ultimate use. The machine shop should be considered as a chip-making department and not a storage area or warehouse.

The second question as to a plan for replacement justification is a sore subject in many ways. In the case of an ideal machine shop, there would of course be an ideal management so there would not be much of a problem. Seriously, the best approach to the situation is to by some means to reduce the question to this: first, can the existing equipment do the job in a manner that produces a component which is satisfactory from a physical point of view, and second, is the cost to produce the part satisfactory from an overall economic angle. Most management groups recognize dollars-and-cents savings as well as time elements, so in the case of a maintenance machine shop, it should not be too difficult to balance the output potential of the shop against tonnage out of the mill.

Answering Mr. Crepeau's comment on the center distance of the large lathes, I quote from the section on this unit: "Center distance for each should be no less than thirty feet." Different shops have different problems which usually are solved in various ways.

Any shop, regardless of how ideal it may be, sooner or later encounters jobs which tax the ingenuity of the supervisory personnel to adapt existing machinery satisfactorily. However, if 35-ft centers are necessary, that is what it shall be.

By FRANK R. HAUSER, Water Engineer, Bethlehem Steel Co., Sparrows Point, Md.

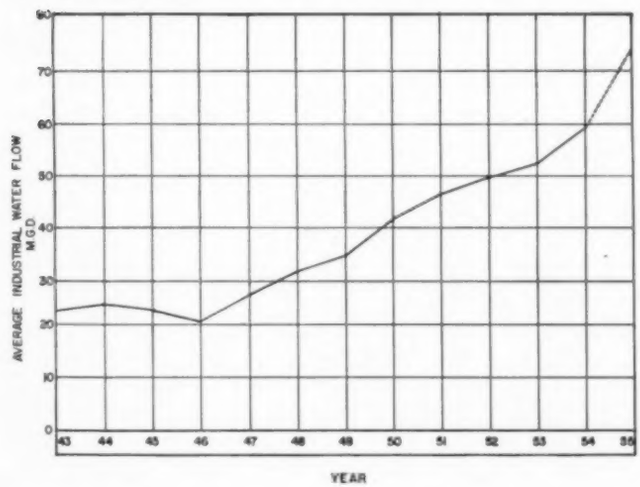
Expansion of Industrial Water Facilities at Sparrows Point

. . . . as steel plants expand, the satisfaction of their demand for water becomes an ever increasing problem . . . . a unique solution is described in this paper where advantage has been taken of the water available from a municipal sewage system . . . .

▲ THE Sparrows Point plant of the Bethlehem Steel Co. initially utilized the effluent from the Baltimore City Sewage Treatment Plant in 1943, in order to augment the large steel plant's demand for water and effectively reduce ground water pumpage. Development of this new water supply involved the construction of a purification plant, a 60-in. diameter reinforced concrete transmission main, a storage reservoir, a high head pumping station, and an elementary plant distribution system. This conversion of a sewage works effluent into an industrial water supply was the solution to a major plant problem.

The original system received effluent from the activated sludge and trickling filter treatment facilities operated by Baltimore City at Back River. Normally, the activated sludge effluent was sufficiently high in quality to warrant only chlorination prior to being sent through the transmission main to Sparrows Point. The trickling filter effluent was taken from the city's humus tanks and treated with 4 to 5 gr per gal of alum in the company's basins, chlorinated, screened, and then conveyed through the 60-in. main to the storage lake.

Figure 1 — The water flow has more than doubled in the past 10 years.



Production of this industrial water had a somewhat erratic but steadily increasing growth curve (Figure 1).

The increase in demand for industrial water required several stopgap installations in the system. In 1948 it became necessary to install an additional 20 mgd treatment tank at the Back River station. The fourth and final vacant space above the suction sump at the high head pumping station was filled by the installation of an 18,000-gpm pump in 1949.

By 1951 the 44 mgd gravity capacity of the 60-in. main was inadequate, and as a result the storage reservoir level was lowered during the high weekday pumpage and was barely able to be refilled during the below average pumpage each weekend. The capacity of the 60-in. diam line was increased at that time by the installation of three vertical, low-lift, 14,000-gpm pumps. These pumps raised the water level in the head basin at the entrance to the transmission main by approximately 11 feet, increasing its total capacity from 44 mgd to 66 mgd. See Figure 2.

In 1952, under pressure from community improvement groups, Baltimore City initiated improvements involving the installation of rotary trickling filter sprays and a mechanical system of humus tank sludge removal. These new systems had a marked effect upon the quality of their effluent.

Prior to 1952, the operational control of quality was the measurement of relative turbidity of the influent and effluent as measured by the scale units of a manual turbidimeter. In the case of the activated sludge water, even though it was normally discharged directly into the 60-in. main, a sample for turbidity was withdrawn. Highly turbid activated sludge discharge could either be given additional retention in the company tanks or else diverted to the city outfall.

Operations felt the effect of the city's improvements in 1951, when it was noticed that the effluent from the final settling basins of the trickling filter process was as

Figure 2 — Addition of a low-lift pumping station increased gravity capacity of 60-in. main 50 per cent.

low as or lower in turbidity than either the activated sludge water or the effluent from the Bethlehem tanks after alum treatment.

The effluent from the final settling tanks in the trickling filter process had averaged from 15 to 22 scale units in turbidity while the activated sludge varied from 10 to 15 scale units. After the improvements were installed and in operation, the final trickling filter effluent turbidity was reduced to 8 to 10 scale units. Operational improvements at the activated sludge plant have resulted in an effluent of similar turbidity.

During 1952 and 1953, considerable data was gathered on alum versus no alum treatment of trickling filter effluent in the Bethlehem Steel Company treatment tanks. The results indicated that in general, alum treatment resulted in good effluent with a low turbidity, BOD, and chlorine demand. However, this improvement in quality obtained through chemical treatment was not significant enough to economically warrant the large yearly expenditure for alum. Gradually, except for periods when the city plant experienced operational upsets, the use of alum was discontinued. Some slight improvement in the water quality can be obtained by taking advantage of the additional retention time and the sludge removal equipment in the Bethlehem treatment basins. These same tests failed to disclose any better operational control test than the measurement of turbidity as it had been carried out previously.

Realizing the imminent shortage of this industrial water supply for plant use, plans were started on a major expansion program early in 1953. The year of 1965 was selected as a target date when a yearly average of 150 mgd will be required.

The design capacity of the three treatment tanks and the activated sludge water, as received direct, provided a maximum supply of excellent quality effluent totaling approximately 75 mgd. Any additional required capacity could be provided through the use of one or more of the four sections of the Baltimore city humus tanks; each section having a nominal design rating of 35 mgd (Figure 3).

For this expansion program it was decided to utilize two sections of these humus tanks with some minor provision for alum treatment of high future flows. A rubber lined alum solution feed pipe was installed from the Bethlehem Steel Company's chemical control building to the inlet of the city's tanks, in order to provide for the application of coagulant when the water quality warrants it. Installation of mechanical flocculators has been postponed until such time frequent alum treatment in these tanks can justify the expenditure. The seven inlet gates to each section of the city tanks can be throttled, when their full capacity is not required, to conserve alum when treatment is necessary and to increase retention time when no treatment is desired. The new facilities provide for the effluent to flow through trough extensions to a new discharge flume, parallel and adjacent to the existing channel to the sewage works outfall. The effluent is collected, chlorinated, screened, and then discharged into the new 96-in. transmission main. See Figures 4 and 5.

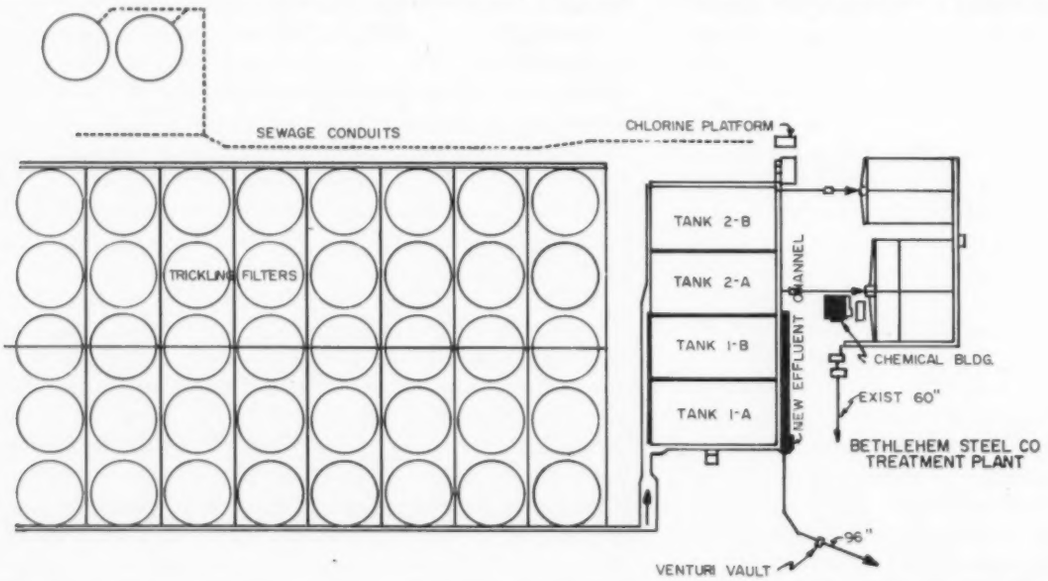


Figure 3 — Each section of the humus tanks has a design rating of 35,000,000 gpd.

A 36-in. cast iron by-pass line is provided between the head basin on the original 60-in. main and the entrance chamber to the 96-in. main. This by-pass will be used either in the event the water quality warrants full use of all treatment equipment previously in-

Figure 4 — Effluent is collected, chlorinated, screened and then discharged into the 96-in. transmission main.

Figure 5 — Provisions have been made for using alum as a coagulant although installation of mechanical flocculators has been postponed until later.

stalled at the company's station or else in the event of an outage of the 60-in. line.

Associated equipment installed at the Back River plant as a part of this expansion program included an additional chlorinator, two sludge pumps, three alum solution pumps, two "house" water pumps, and additional metering and alarm instruments.

A 96-in. diam steel line, 4½ miles long, carries the water from Back River to the storage reservoir at Sparrows Point. The line is coated with coal tar enamel and is felt wrapped. The wall thickness varies from ½ in. to ⅝ in., the use of any wall thickness being governed by the backfill loading of a particular section in the area. The main was installed using 40-ft sections joined by internal and external arc welding. A 36-in. entrance manhole is provided every 500 ft, 36-in. air vents at the high points and 24-in. diam blow-offs at the low points. The new main roughly parallels the 60-in. supply line, but is spaced far enough away to offer protection against an outage on both mains simultaneously in the event of a disaster in the vicinity of either. A 96-in. butterfly valve is installed at the outlet end of the main where it discharges into the storage reservoir. See Figures 6 and 7.

Operation of the 96-in. main requires that it be maintained full of water at all times rather than be alternately wet or dry along the upper perimeter during periods when the flow at Back River fluctuates. In order to take advantage of additional retention time, the Bethlehem basins are base loaded with all of the activated sludge water and the balance, to meet 60-in. main gravity capacity, is taken from the trickling filter effluent. All additional requirements of the Sparrows Point plant are transferred through the 96-in. line from the new flume. Control of the opening of the butterfly valve permits the operator at the reser-

Figure 6 — Pits were dug in the trench for the 96-in. line at each joint to help in joining the pipe sections.

Figure 7 — The installation of the 96-in. line was a major construction task.

Figure 8 — Control by a butterfly valve permits the reservoir pumping station operator to maintain a full lake.

voir pumping station to maintain a full lake. During the early morning hours when the Baltimore City sewage flow is low the butterfly valve will be close to, or completely, closed, the pumping stations being supplied by the water available in the 60-in. main and the withdrawal from the storage lake. As more water becomes available at Back River, the butterfly is gradually opened, refilling the reservoir (Figure 8).

Impressed current is used in a cathodic protection system for the outer surface of the pipe in order to supplement the protective coating.

The industrial water delivered from Back River was stored in an earth reservoir with a total capacity of 85,000,000 gal. However, with the original pumping station operating at full capacity, only 32,000,000 gal was usable. By raising the lake overflow weir 1½ ft, 19,000,000 gal additional storage was obtained. The new pumping station is designed to operate at full capacity with the lake level at 5 ft below the overflow weir, giving an additional 12,000,000 gal of water in storage. The combined total usable storage of the lake is 63,000,000 gal, or approximately a day's supply under present operating conditions, with no water being received from Back River.

Additional pumping capacity has been provided for by the construction of a new pumping station 950 ft west of the original station. Expansion of this original station was economically and hydraulically unsound. The decision to start a new station at another site on the reservoir takes advantage of a low elevation open ended suction sump and remaining along the line of an extension to the plant distribution system.

The new station is constructed of brick with a suction sump that is essentially a part of the reservoir. Two rotating screens, a chlorine distribution header, a vacuum pump priming system, two 24,000-gpm at 175-ft head pumps, and an electrical substation are the major components of this installation. Provision is made for the future expansion of this station with three additional pumps of similar characteristics. A channel has been dredged to a deep water section of the lake (Figures 9 and 10).

The two pumping stations are connected by a 60-in. steel main; another 60-in. steel main 7,000 ft long completes an important loop feeding the plant through the rod and wire mill area. At the same time, approximately 2,000 ft of 48-in. steel main links the new 60-in. with a 30-in. main, supplying the coke ovens from the vicinity of the plate mills.

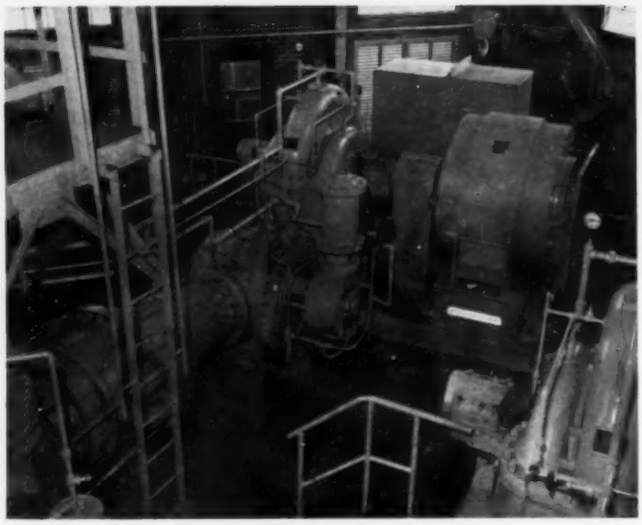
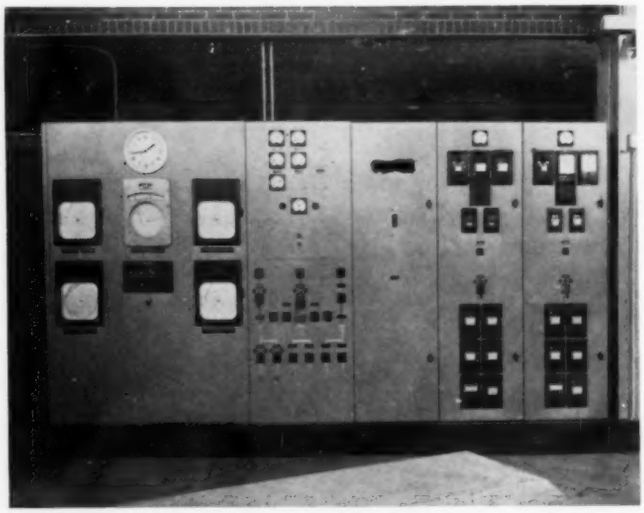


Figure 9 — Two 24,000-gpm, 175-ft head pumps are located in the new pumping station.

Figure 10 — Panel board in the new pumping station unit helps in the control of water operations.



A 750,000-gal elevated storage tank, which was part of the original system, remains in service and is a guide to pumping station operation. The new station is base loaded with one pump in operation and the original station varies its output in order to control the level in the elevated tank. The protection once provided by the elevated storage is gradually declining, since at present system flows, it would last only 14 minutes during a total power failure at both stations. Salt water system cross ties within the plant, and a flexible, firm power supply at the pumping stations compensates for the protection previously afforded by what was a high capacity elevated storage.

The satisfactory record of the use of this water supply in steel plant operations indicates that its popularity will increase proportional to all increases in finished steel production facilities.

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DISCUSSION

PRESENTED BY

L. F. COFFIN, Assistant General Manager, Bethlehem Steel Co., Sparrows Point, Md.

J. M. SPENCER, Assistant Fuel Engineer, Bethlehem Steel Co., Sparrows Point, Md.

D. H. PANGBURN, Engineer, Bethlehem Steel Co., Sparrows Point, Md.

FRANK R. HAUSER, Water Engineer, Bethlehem Steel Co., Sparrows Point, Md.

PAUL E. BARDET, U. S. Metal Refining Division, Sub American Metals Co., Carteret, N. J.

L. F. Coffin: Back in the early days when Sparrows Point was dependent on artesian well water as the only fresh water in Sparrows Point, it was necessary in order to expand the steel plant to have a large, adequate supply of fresh water.

Consequently, the use of this reclaimed sewage water supplied the need and marked a unique step in steel plant development.

The city sewage system in Baltimore is below river level, and the river water is tidal and salt. It has about one-quarter to one-fifth the salinity of sea-water. When there is a strong southeast wind, the level of the water in the river rises considerably above the level of the city sewage radius. Consequently, at those times the city's sewage system would be contaminated with salt water, to such an extent the water was not usable as roll cooling water at Sparrows Point. We have an upper limit of 175 ppm of chlorides. When you get too high in chlorides, you start to get etching on rolls.

Some of the men back in those days managed to get down into the Baltimore sewage system. They actually traveled through the main trunk line sewers in Baltimore City at periods of low flow in order to find the source of the leaks, which with the cooperation of the city were corrected, bringing the salinity to a usable figure. This little background may be interesting in illustrating some of the cooperative problems involved to develop a system mutually advantageous to both the city and the company.

J. M. Spencer: Mr. Coffin mentioned the fact that in original work on this system we had to do considerable survey work in the city. I happened to be one of those that did some of that survey work and of necessity we had to do a lot of the work at night, because it involved sampling the city's sewers and most manholes were in the streets, so a great majority of the work was done between 9 pm and 6 am.

One thing Mr. Hauser did not mention is the fact that although this steel line is coated, it has been necessary to resort to further cathodic protection due to the fact that the Baltimore Transit system results in some high currents running down this steel main.

D. H. Pangburn: Since I was involved in the engineering of the 96-in. line, I would like to comment on the size. The author pointed out that we figured on getting 150,000,000 gal per day in 1965. We already have a 60-in. line; we added a 96-in. line. These two lines have a combined capacity rate of 210,000,000 gal per day with the 12-ft available gravity head.

During certain hours of the day, the flow from the sewage plant is very high while other times of the day, it is much lower. In order to capture a total of 150,000,000 gal per day, it is necessary to have a pipe line capacity great enough to handle the peak flows. It worked out that a 96-in. line in addition to the existing 60-in. line would have the proper capacity.

The figure showing the pumping station might give one the impression that the building is very high. The height is necessary for a hand-operated overhead traveling crane to carry a pump motor over top of a second motor.

Frank R. Hauser: I have two thoughts I would like to bring out at this time. One is of the tough problem of a water man in a steel industry in setting the standards for the use of water in a mill. For instance, Mr. Coffin mentioned the limit of chlorides as being 175 ppm. That is about the only guide that we had, and that was set up quite a few years ago by men who initially worked with this system. However, what I am really getting at is, what do we need for limits of sulphate, calcium, etc., what are the limits the steel men require and consider a good quality water for steel mill use? It is something to think about; it is something on which we need some work. It will be easier for the water man if one can tell him the limits of any of the constituents of the water for steel mill use. The second thing is that we have been so successful in the use of this water, why does not more of the industry use it?

Paul E. Bardet: I was a sewage treatment man at one time. You made the statement, why do not more of us use it? Can we expect a small town with say trickling filters, to be able to give you good enough water for industrial use without equally going overboard trying to treat it? What are the requirements that you request from Baltimore, which happens to be one of the most efficient sewage treatment plants in the country, if not the most efficient—what do you request from them in suspended solids and dissolved oxygen, which I think would be the important points?

Frank R. Hauser: In 1945 in Water Works and Sewage, in the same issue that had the paper by Mr. Hill, there is a discussion by a Mr. N. Kenny, of Whitman, Requardt and Associates, of the contractual agreement between Baltimore City and the Bethlehem Steel Co. I can not recall all of the contract, but I can answer this, that we require in that contract a pH of 6.5 to 7.8, a maximum monthly average chloride of 175 ppm, and suspended solids monthly average of 25 ppm. You would have to refer to this paper to get the rest of the contract. However, there are only a few other quality requirements that are specifically named.

You mentioned the activated sludge process as being very helpful to us. It has been, but now, in the expansion program, we have been fortunate enough to get the trickling filter water down to a quality where as yet we have not had to use alum. When we were using alum, we found we could supply the water to the plant, including cost of treatment, distribution, materials, pipe, and even installation of small services —all paid for and charged against this system, at a rate somewhere around two cents per thousand gallons.

LEARNING

By HAROLD F. MILLER
Assistant General Manager
Bethlehem Steel Co.
Bethlehem, Pa.

▲ EVERY integrated steel plant requires an abundant supply of water, which is one of the determining factors in its location. Sometimes, when nature goes on a rampage, this supply becomes uncontrollable and we are out of business. To learn how to live with this problem, one must learn to live with the river.

For those who are fortunate enough to have their plant protected by a flood control system on their river, this will not be of much interest. To others who have somewhat the same problem as ours, we offer our condolences.

The Bethlehem plant has had about 100 high water incidents over the past 55 years. Many of these did not reach a level high enough to affect operations; a few resulted in partial curtailments, while three reached levels causing total plant shutdowns. These three occurred in 1902, 1942 and 1955.

The 1942 flood provided the impetus for setting up a flood procedure that would minimize the extent of physical damage to plant facilities, and allow resumption of operations in the fastest possible time after the waters had receded.

It was realized that we had no control over actual river rise, and that once we reached certain levels, there was nothing to do except observe the flow of water and debris through the plant, with full knowledge of its disastrous effect on steelmaking facilities. How then, does one approach such a problem where there is no control over the cause factors? This is what we did at Bethlehem.

The fuel division of the plant was commissioned by management to carefully organize a plant flood protection plan. It was a logical choice at Bethlehem, since this organization functions as the operational control agency for the plant in all matters that may require curtailments or shutdowns.

After carefully reviewing the results of this flood, our approach to the problem was based on three assumptions.

1. Water levels can be predicted with reasonable accuracy at least six hours in advance, if we had knowledge of the general watershed, and had the facilities to acquire the needed information.
2. Damage and delay to plant operations can be minimized by the proper and timely organization of plant personnel and resources.
3. Operations can be resumed and damage repaired more quickly if instructions and material were listed and on hand when the need occurs.

Figure 1 is a map showing the general watershed of the Lehigh River. It comprises an area of approximately 2,000 sq miles as outlined by the heavy broken line.

In order to satisfy our first assumption pertaining to receipt and interpretation of watershed information, a system was set up for obtaining river gage readings from upstream locations at White Haven, Jim Thorpe, Lehighton and Allentown, as well as at our own plant in Bethlehem.

The stations at White Haven and Jim Thorpe, which are fifty and thirty miles upstream, respectively, or twelve and seven hours ahead of Bethlehem in crest time, were operated by The Pennsylvania Power & Light Co. in conjunction with their substation operations. Two years ago, these substations were relocated and the gaging stations abandoned. Efforts are currently underway to re-establish a new station at White Haven, to be operated by some reliable agent.

The Lehighton station, which is twenty-five miles upstream or six flood hours away, is our most reliable source of information. This post is manned by the regular U. S. Weather Bureau Observer, who gives us the same information given to the Weather Bureau in Allentown. The plant pays him a retainer for this service and for any other additional information we may require.

The Allentown station is six miles upstream or about one hour away. It is operated by the Lehigh Valley Division of United Gas Improvement Co., and by agreement supplies us with hourly or half-hourly river gage readings as requested.

All this information on river readings is received at the central gas dispatcher's office, which becomes the key coordinating point in the plant. Here it is plotted on a graph form as shown in Figure 2. These curves show the rate of rise and the time of cresting at stations in Lehighton, Allentown, and Bethlehem. Coupled with rainfall information and a knowledge of general conditions in the watershed, such as temperature and soil status, these readings form the basis for a prediction of time and height of cresting in Bethlehem. As additional information is received, this may be revised up or down as indicated by new developments.

At this time it would be well to emphasize the importance of weighing very carefully all incoming weather and river data. We have learned that often basically sound information can be misinterpreted, and if accepted without reservation, can lead to wrong conclusions.

In our opinion, the collection and interpretation of this weather data is the crux of our whole program, for on its accuracy hinges the time interval available for plant flood protective measures. Needless to say, no one wants to stop production on a blast furnace unless it is absolutely necessary. On the other hand, neither does a blast furnace operator want to be caught with

TO LIVE WITH YOUR RIVER

. . . . although the steel plant engineer cannot prevent floods, careful advance plans and preparations will not only minimize flood damage but expedite getting the plant back into operation . . . .

a furnace full of metal or a string of hot metal and slag cars marooned in a swirl of water.

Having established a method for predicting when and to what extent the river is expected to rise, the next step in formulating this program was the listing of all pieces of equipment in relation to the elevation at which it will be affected by this rise.

Each one of these locations was reviewed and investigated to determine what could be done, if anything, to lessen their vulnerability to the river rises. The topography of the plant is such that water will overflow the banks of the river at an elevation of eighteen feet above normal. After this happens, there is very little to be done but wait until it recedes. However, we do have many spots that are vulnerable at elevations lower than this. It was these locations that received our attention.

In many cases, simple barricading or closing-up foundation wall openings was all that was needed. In others it was necessary to install shut-off valves in sewer lines. In still others provision for pumping seepage or gasketing and bolting sewer man hole covers did the trick. All in all we were able to achieve complete protection in some cases, while in others we materially improved elevation levels at which they would be affected. All these improvements afforded us valuable time toward shutting down operations and protecting equipment during our major floods, and provided greater protection against the many other river rises that crested lower than eighteen feet.

Today, new equipment going into the plant is always considered in light of its protection against flood waters, either through water proofing or positioning above the elevation of our major flood crests.

Having established the basis for predictions and area vulnerability, the next step was to organize plant personnel and resources. Meetings were held with each department head, where we discussed propositions pertinent to his operations. Here a procedure was set up to combat high water periods, the proper personnel and tools listed in addition to when and how this personnel was to be notified of the emergency.

As a result of all this study and discussion, the original "Bethlehem Plant Flood Data" manual was formulated. This is presently a 162-page book covering the procedures, instructions, graphs, notifications lists, operations detail lists, motor data and all other facts pertinent to the program.

The manual is a loose-leaf note book, since additions and corrections are constantly made to it, in order that the original purpose of the effort may be more fully attained.

These books are distributed to thirty executive and key personnel of the 21,000 employees. They are periodically discussed and studied at divisional meetings, in order to emphasize the subject matter, and to establish familiarity with the responsibilities and duties of each and every one subject to call.

The mechanics of protecting the plant during one of these emergencies involves a great deal of detail that is primarily concerned with one's own individual problem. However, we would again like to review the major factors involved in such a program and then offer an illustration as to how the plan operates.

As mentioned before, the up-to-date information of what to do at certain river elevations, plus the personnel required to do it, is now a matter of reading the Flood Data Manual. Likewise, equipment lists, sources of supply for pool labor, and the location and availability of required tools are just a matter of a telephone call. The only thing that does change from incident to incident is the "crystal ball" accuracy of those responsible for predicting time and height of river cresting. In this accuracy lies the effectiveness of the program. That is why learning all you can about your river and its tributaries is so important. Each incident must be evaluated by itself, since experience has shown that conditions at the time have a tremendous influence, whether it be fifty miles upstream or localized. For instance, we have had cases which showed the same initial rate of rise as our major floods, but fortunately crested without requiring a shutdown.

In matters such as this, it is of course easy to second guess after the emergency is over. In fact, there are

some people who feel we should start a shutdown a lot sooner than we do. It is true, if we were more conservative in our judgment perhaps a few more motors could be saved, or we could give ourselves a greater safety factor in curtailments. On the other hand, had we followed this school of thought over the years, we would have had unnecessary shutdowns many times. A shutdown is not a pleasant job in a steel plant, with all of its innate hazards, not to mention loss of production or the deleterious effect on equipment.

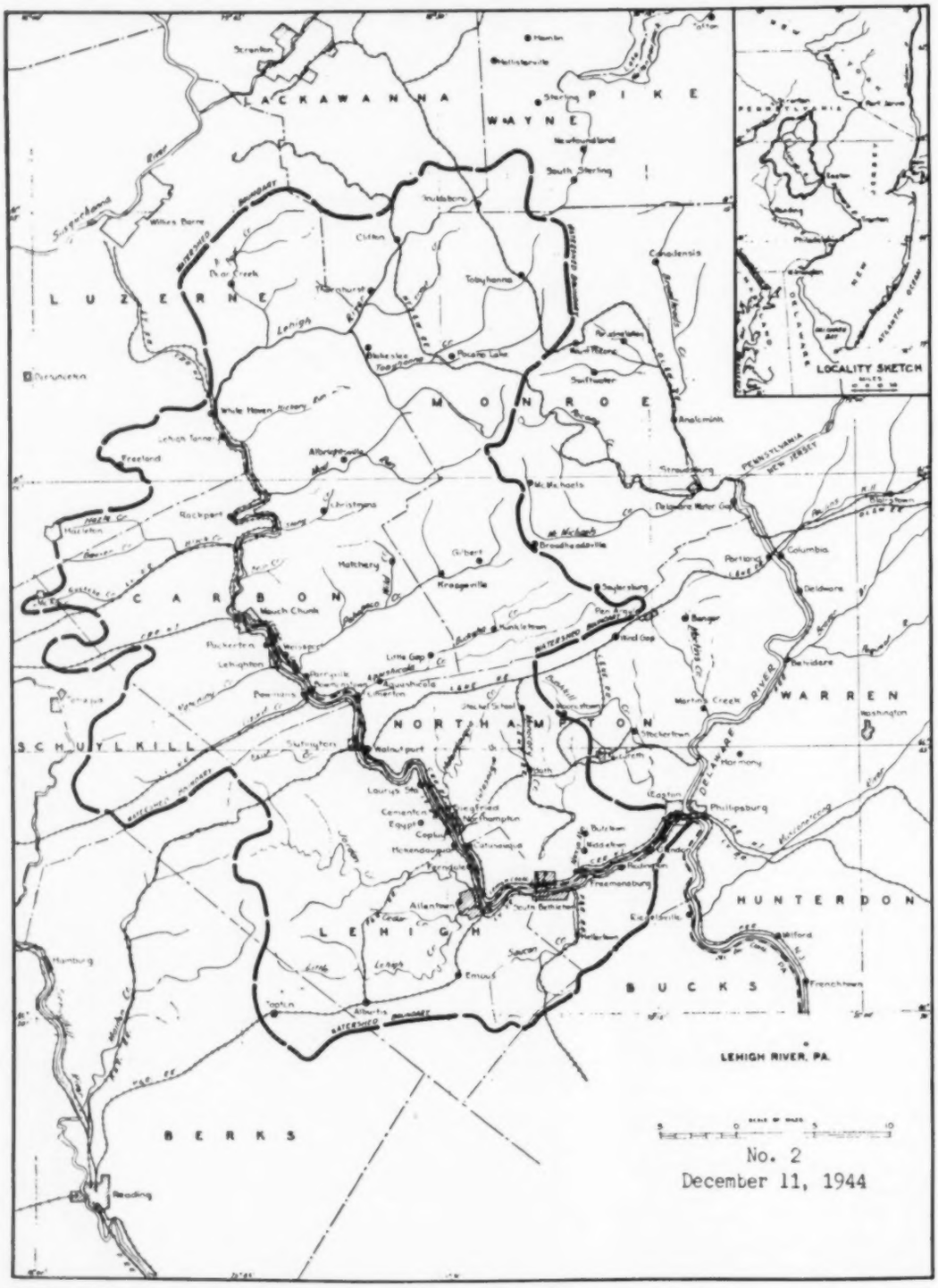

Figure 1—Watershed area for the Lehigh river totals about 2000 sq miles.

Our last two major floods occurred in 1942 and 1955. In the 1942 flood, we were caught unprepared and suffered extensive damage. All decisions had to be made on the spur of the moment. We all know, it is one thing to shut down a steel plant in a planned and orderly manner, but it is quite another thing when it catches you unprepared, both from an equipment and a personnel standpoint. That our flood program has merits, was demonstrated in the 1955 flood. Not only were we able to shutdown in a more orderly fashion, but we were able to get back into business a lot sooner in many of our operations. This can be attributed to the planning as set forth in the manual and the time interval provided to marshal the required personnel and equipment toward the protection of the more vital areas. This is even more impressive considering the greater amount of mechanical and electrical equipment now in service as compared to 1942.

It must be kept in mind that this program can never be one to completely protect all equipment of the plant,

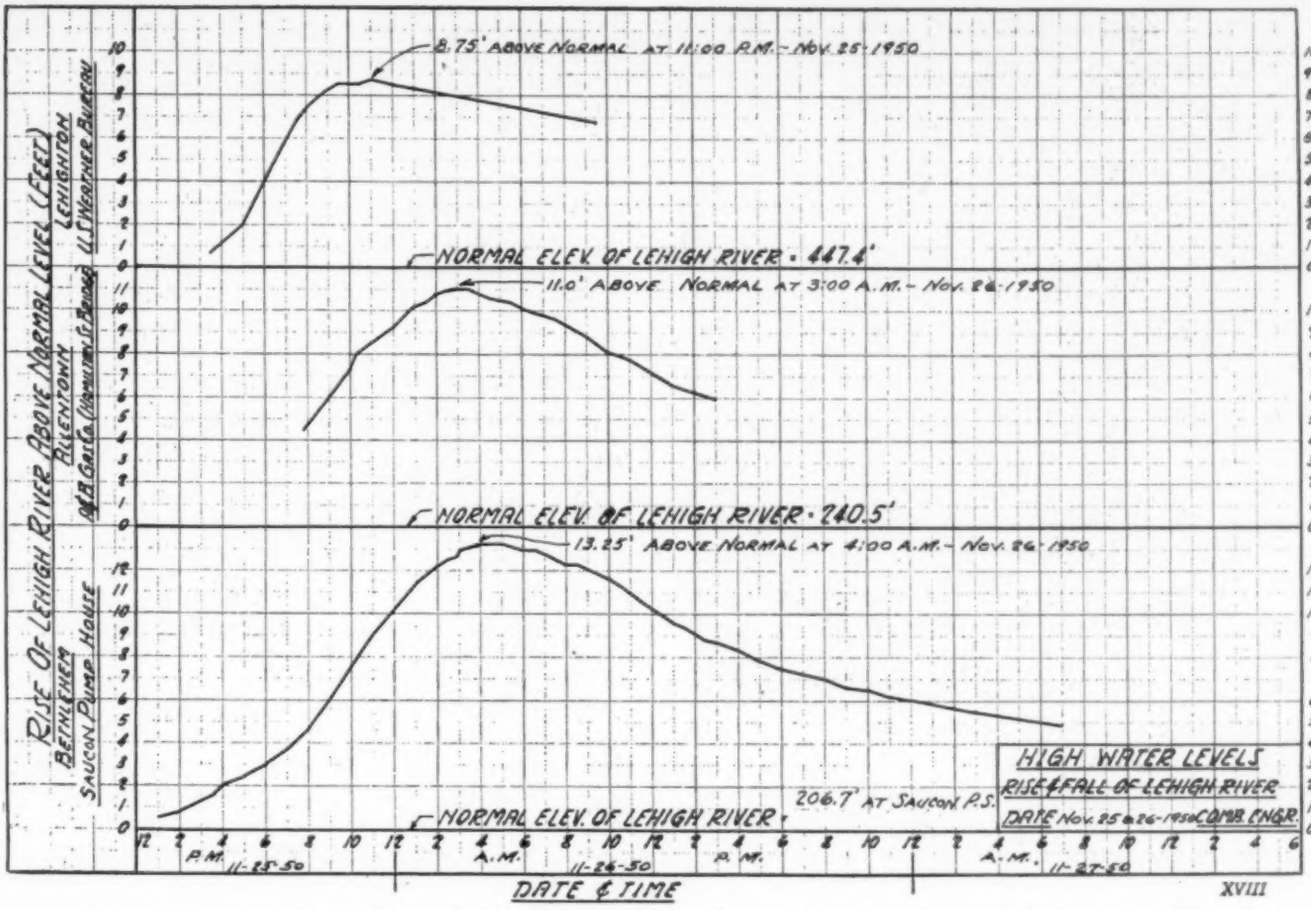
RISE OF LEHIGH RIVER ABOVE NORMAL LEVEL (FEET)
BETHLEHEM
SAUCON PUMP HOUSE
ALLENTOWN
LEHIGHTON
M.A. GATZ (VIADUCT ST. BRIDGE)
U.S. WEATHER BUREAU
8.75' ABOVE NORMAL AT 11:00 P.M. - NOV. 25, 1950
NORMAL ELEV. OF LEHIGH RIVER - 447.4'
11.0' ABOVE NORMAL AT 3:00 A.M. - NOV. 26, 1950
NORMAL ELEV. OF LEHIGH RIVER - 240.5'
13.25' ABOVE NORMAL AT 4:00 A.M. - NOV. 26, 1950
206.7' AT SAUCON P.S.
NORMAL ELEV. OF LEHIGH RIVER
HIGH WATER LEVELS
RISE & FALL OF LEHIGH RIVER
DATE Nov. 25 & 26, 1950 COMB. ENGR.
P.M. 11-25-50
A.M. 11-26-50
P.M.
A.M. 11-27-50
DATE & TIME
XVIII

Figure 2 — Rise and fall of Lehigh river at three different stations shows movement of crest down the river

but rather to concentrate on those units which are most vulnerable and important in the scheme of getting the plant back into operation. Sufficient time is not available to allow much more. Only an intensified flood control program on the river itself will accomplish this end.

The following will describe the highlights of our most recent flood experience. Perhaps we can better demonstrate how our program functions if we tie in the procedure with this specific event.

The Bethlehem plant is composed of three distinct areas. Topographically, the Lehigh division is the area vulnerable to high water. It includes blast furnaces, blowing and generating stations, a few open hearths

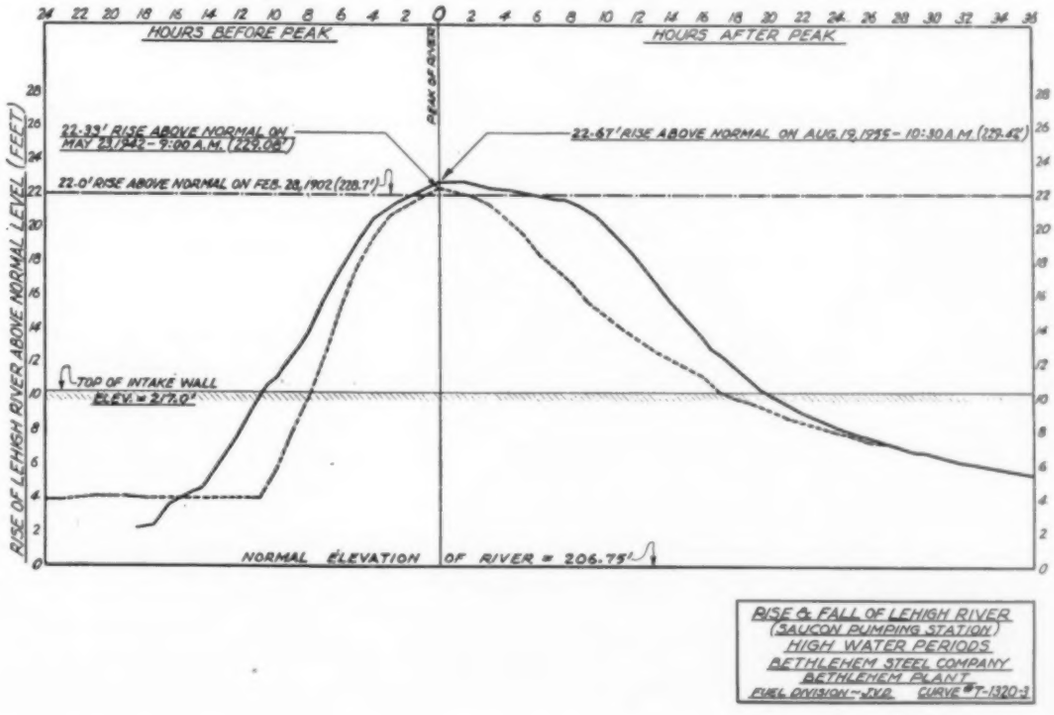
HOURS BEFORE PEAK
PEAK OF RIVER
HOURS AFTER PEAK
RISE OF LEHIGH RIVER ABOVE NORMAL LEVEL (FEET)
22.33' RISE ABOVE NORMAL ON MAY 23, 1942 - 9:00 A.M. (229.08')
22.67' RISE ABOVE NORMAL ON AUG. 19, 1955 - 10:30 A.M. (229.42')
22.0' RISE ABOVE NORMAL ON FEB. 28, 1902 (228.7')
TOP OF INTAKE WALL ELEV. = 217.0'
NORMAL ELEVATION OF RIVER = 206.75'
RISE & FALL OF LEHIGH RIVER
(SAUCON PUMPING STATION)
HIGH WATER PERIODS
BETHLEHEM STEEL COMPANY
BETHLEHEM PLANT
FUEL DIVISION - ENG. CURVE NO. T-1320-3

Figure 3 — Three worst floods of the Lehigh river in the last 50 years at Bethlehem were due to river rises between 22 and 23 ft.

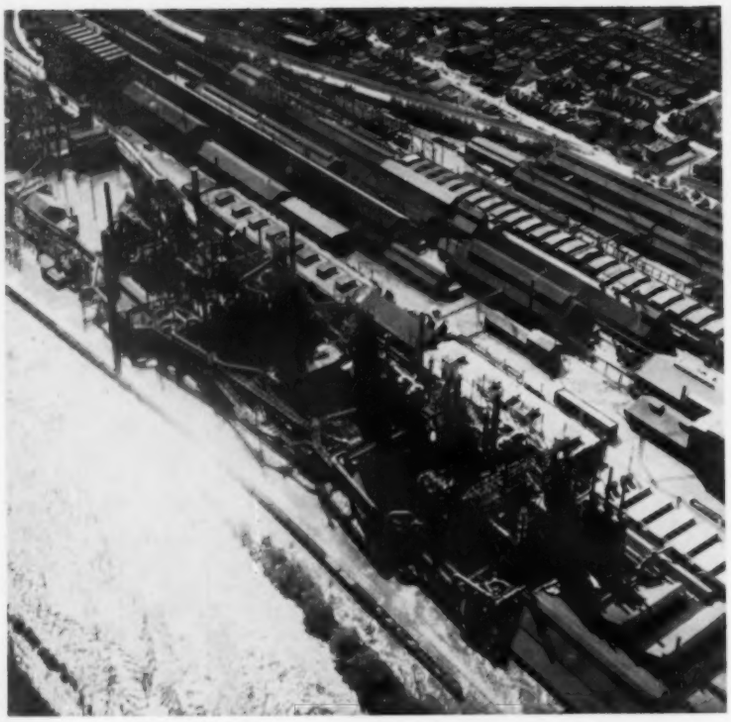

Figure 4 — Blast furnace area has been completely flooded.

and the alloy mills, along with numerous manufacturing shops and foundries. Although the remainder of the plant is not hit by high water, it does feel the effects of curtailment of such major basic production units as blast furnaces, as well as interrupted service, facilities.

On August 12th and 13th, we had very heavy rains in the entire Lehigh watershed, as a result of hurricane "Connie." This left the area thoroughly saturated, but did not pose a serious flood threat, although the river did go to about five feet above normal.

Figure 5 — Crest of flood was higher than expected due to unforeseen collapse of several dams up the river.

On August 18th, we again experienced torrential rains caused by hurricane "Diane." These rains started late in the afternoon and deposited two to four in. over the area in one hour, and a total of six to eight and one-half in. throughout the watershed in a period of twelve hours. By seven o'clock in the evening, it became apparent that the river was rising at an alarming rate. At this time our standard procedure for collecting river data had already been in effect. From this data, qualified personnel predicted that the river would crest approximately eighteen feet above normal about 3 o'clock the following morning. This prediction was made shortly before 10 pm when the river was standing at seven and one-half feet above normal. In the meantime, up-to-the-minute information was continuously relayed to the proper personnel, so that all preliminary work, such as barricading and valving as outlined in the manual, was underway. At 10 pm, based on the predicted eighteen-foot crest, shutdown procedures for the blast furnaces were initiated, since their stockhouse is effected at a fourteen-foot rise, and the general yard level is inundated at eighteen foot. Subsequent additional heavy rains, plus dams giving away in the upper water shed, produced an actual crest of 22.67 ft above normal, seven hours later than the original prediction.

When it became apparent that the river level would exceed ten foot above normal, the group of predetermined key personnel were notified, as instructed in the manual. This group is comprised of certain departmental superintendents and maintenance men who require the most time for organizing their protective facilities.

Shortly thereafter, a second group of personnel was notified, when it became apparent that the river was going to twelve foot. This group includes the plant manager and division superintendents who organize their areas for whatever is needed to supplement the work already underway by group No. 1.

These key men, keeping abreast of the situation continuously through information and direction from the central coordinating point, are responsible for whatever rescheduling may be required to balance their operations, and for the protection of equipment through the utilization of plant resources listed in the manual.

Figure 3 shows graphically the magnitude and duration of the last two major floods. In addition, it indicates a level for the 1902 crest, for which detail data is not available. It is plotted with hours before and after crest against feet of rise.

The broken line shows the 1942 flood, while the solid line gives the 1955 high water level. Of interest is the fact that all three of our major floods crested between twenty-two and twenty-three feet. This is presently our elevation reference for the protection of equipment.

You will note that the rate of drop was much slower for the 1955 event. This is considered due to the additional prolonged rainfall and dam failures upstream, as previously mentioned.

To illustrate the appearance of our plant at a twenty-two-foot crest, Figure 4, which is an aerial photo-

Figure 6 — Prior preparations reduced flood damage.

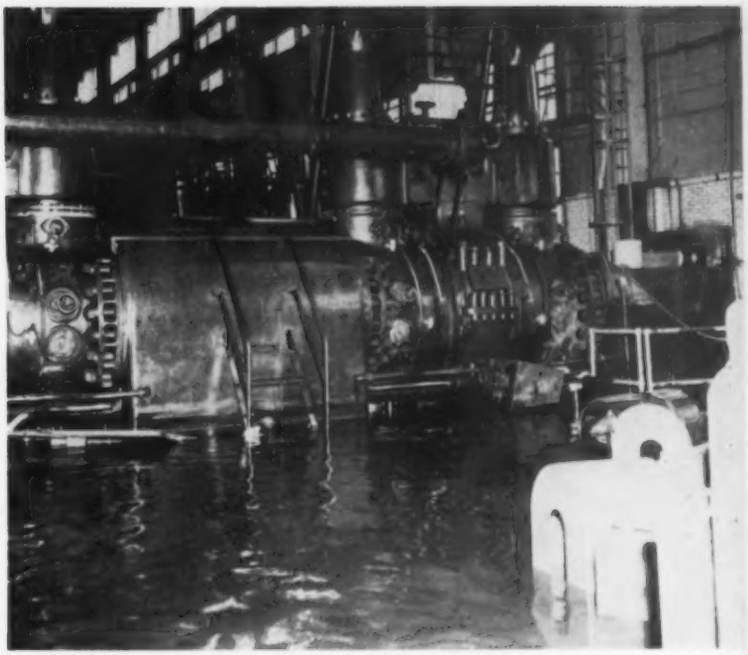

Figure 7 — Water reached a height of two feet above operating floor in the gas engine blowing house.

graph, shows a general view of an area of the Lehigh plant, with the river in the foreground bordered by the LVRR, blast furnaces, blowing and generating stations, manufacturing shops, and extending into the city streets beyond.

Figure 5 is another view, looking downstream. It includes the alloy mills area in the foreground.

Figure 6 is a view showing the east end of the blast furnace area at the crest. The river is off to the right. At this time the water was about five foot above yard level.

Figure 7 is a view of the gas engine blowing house, where water reached a height of two foot above the operating floor.

We are all familiar enough with steel plant equipment to visualize the extensive damage possible with waters on this magnitude. To minimize this damage is worth many times the effort used in setting up a procedure. We feel that what we have done is basically sound, but recognize the need for continual revision and improvement to our program, as we gain more and more experience in dealing with our problem, the river.

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are you getting GOOD RETURNS from your ventilating investment?

By DR. ALLEN D. BRANDT

Chief Industrial Hygiene Engineer, Bethlehem Steel Co., Bethlehem, Pa.

▲ BEFORE proceeding with the subject matter at hand, it may be well to point out that this discussion is confined to ventilating equipment installed in factory or mill buildings for the purpose of controlling heat and air contaminants (dusts, gases and mists); the many other kinds of ventilating installations are not covered.

There is no need to prove that ventilating equipment is costly to install, to operate and to maintain. This is well recognized. However, how many know whether the equipment they bought is accomplishing the objective for which it was installed. To be sure, most equipment of this kind brings about improvement in the air conditions in the area under consideration, but how much improvement. Has the goal on which the design was based or the selection was made been achieved? If not, why not? Were some important factors overlooked, were the existing conditions not understood well enough to permit translating them into engineering design specifications, or does the equipment not measure up to the manufacturers' claims or performance data? These, and a host of other questions need to be answered if the design and selection of ventilating equipment for heat, dust, gas and mist control are to be placed on a scientific and economical basis.

Rather than review and emphasize principles on which the engineering design and selection of ventilating equipment should be based, this subject will be developed largely by discussing several installations which have fallen short of their mark, or would have done so if the course had not been changed en route. Some of the common pitfalls thus will be highlighted.

Air starvation—In the early years of World War II when production and upkeep of the implements of war were growing by leaps and bounds, the spray painting area in a large unpartitioned building at an Army Air Depot became wholly inadequate and had to be expanded. Since the objects being painted (sections of plane fuselages, wings, etc.) were rather large, and since the peacetime program had limped along on a starvation economy, the spray painting area was merely a wing of a one-story building in which mist control of a sort was accomplished by means of propellor fans in the building wall along one side of the spray painting area. By positioning the object being painted directly in front of the fans in the wall, and spraying toward the wall, rather good mist control was achieved. When increased painting facilities became a must, additional fans were obtained and installed in the opposite wall of this wing of the building. About the same time, new building construction was started nearby, and to avoid paint imperfections caused by dust from the earth moving equipment, the doors and windows in the building were kept closed as well as possible.

As soon as the new fans were placed in operation, the painters complained vigorously of paint mist and vapor concentrations in the air. Whenever the original fans only were operated, conditions were not bad, but when the new fans operated also, all of the employees in the painting wing objected to the air contaminants. An investigation revealed that the new fans were of greater capacity and of higher speed than the original ones in the opposite wall, with the result that when the doors and most of the windows were closed, the direction of air flow through the old fans was reversed by the negative pressure created in the spraying wing by the new fans. Consequently this air became grossly contaminated by the painting along the original wall and then traversed the area of the building wing occupied by the painters. The condition was corrected by installing a bank of air filters in the building wall most remote from the nearby building under construction.

The instances in which ventilating equipment, especially local exhaust systems, are prevented from attaining their objectives because of "air starvation" are numerous. Everyone knows that air cannot be removed from a building or space faster than it enters, yet few engineers in industry give any thought to make-up air. Admittedly, this factor needs no consideration in many open buildings of the steel mill variety, but in other types of buildings the infiltration around doors and windows cannot be counted upon to provide adequate make-up air for exhaust systems. Not only must provision be made for air to enter the rooms or buildings from which it is exhausted, but frequently it must be heated in cold weather to prevent chilling of employees stationed near the entrance.

Factors affecting air flow are so varied that each application of ventilating equipment deserves individual consideration . . . . fundamental principles and concepts must be fully considered to avoid trouble . . . . application of manufacturers' data to plant installations must fully consider differences between test and plant conditions.

Gas control in electric generating building—The use of blast furnace gas at the rate of about 53,000 cfm as the fuel for huge internal combustion engines driving electric generators resulted in higher than desirable concentrations of carbon monoxide throughout much of the building which was occupied by about 15 employees. Concerted efforts to eliminate the gas leaks and to control them by means of local exhaust ventilation were unsuccessful, and careful studies showed that there was no major gas leak but rather many minor ones scattered throughout the building. The total amount of gas escaping was small, but since it contained almost 30 per cent carbon monoxide and since the threshold limit for CO is 100 parts per million (0.01 per cent) even small leaks created an unacceptable condition in this large building 440 x 190 x 47 ft high.

At this point a ventilating firm was invited to observe the conditions and to suggest remedial measures. Following several conferences between plant representatives and the engineers from the ventilating firm, it was decided to install roof fans in six of the high sections of the roof which was a high-low bay construction with openable window sections forming the vertical portions of the roof structure. The fans were to be of 60,000-cfm capacity each, the total proposed ventilation rate being 360,000 cfm. Before proceeding with the purchase and installation of the roof fans, a careful analysis was made of all aspects of the problem to determine if possible whether the roof fans would bring about the desired improvement. This analysis revealed some startling things. In the first place, a sketchy study of the natural ventilation rate through the building with the roof windows "as found" indicated that it was about 420,000 cfm, or about 15 per cent above that of the proposed roof fans. Obviously the roof fans would not have achieved any improvements on the other days when the climatic conditions were similar or even more favorable. In the second place, while the roof fans would have improved the conditions for the bridge crane operator on days when the natural ventilation was at a minimum, they would not have controlled his exposure, because it was higher than desirable on days with good natural general ventilation. In the third place, the operating floor area on which most of the men were occupied would not have been affected significantly by any amount of roof ventilation, because most of the make-up air would enter the room through windows in the long walls and flow toward the roof thereby shortcircuiting the major portion of the floor area.

This example teaches two important lessons to bear in mind at all times when dealing with general ventilation. First, the rate of ventilation must be high enough to dilute the contaminant to a hygienic level. A natural corollary is that general ventilation usually is not satisfactory to control major sources of air contamination because the required ventilation rate is very high. Secondly, the direction of air flow must be such that relatively clean air passes through the breathing zones of the exposed employees.

The discussion of this case history might end here, since it has been shown that good returns would not have been realized from money invested in roof fans. However, the problem was solved successfully and how this was done is of sufficient interest to warrant telling at this point.

The second requirement as to general ventilation, an inherent weakness in any scheme of exhaust ventilation for this building, pointed the way to successful gas control for the employees on the floor. The building had a partitioned basement which could be adapted to serve as a plenum for supply ventilation if grilles were installed in the floor at appropriate locations. This was done and two centrifugal blowers having a total capacity of 350,000 cfm at 2 in. water gage static pressure were installed to supply air to the building through appropriate sections of the basement and the open gratings in the floor. By introducing the air in this fashion, it traversed the areas normally occupied by the employees before it picked up much of the leaking gas, most of which escaped at the engines and tended to rise toward the roof because of a temperature difference. As a result, the average CO concentrations on the operating floor have been reduced to a level well below the threshold limit of 100 ppm.

However, the crane operator's exposure continued at an unsatisfactory level, because the general ventilation rate was not great enough to dilute all the escaping gas to an acceptable concentration. Please remember that the crane operator was overhead and therefore was directly in the contaminated air rising to the roof where it escaped to the outside, whereas the men on the operating floor essentially were on the clean air side of the major leaks, and consequently were in air that had not been contaminated to an unacceptable degree.

A unique arrangement was devised whereby outside air is supplied to the crane cab irrespective of the position of the crane in the building [1]*. This arrangement is shown in Figures 1, 2 and 3. Uncontaminated outside air is blown into a duct located at cab level and running the entire length of the building. The shape of the duct is shown in Figure 1 and its location with respect to the crane cab is illustrated in Figure 2. The rubber belting forming the lower part of the supply duct (Figure 1) serves as a valve which is held in

*Numbers refer to bibliography at end of this article.

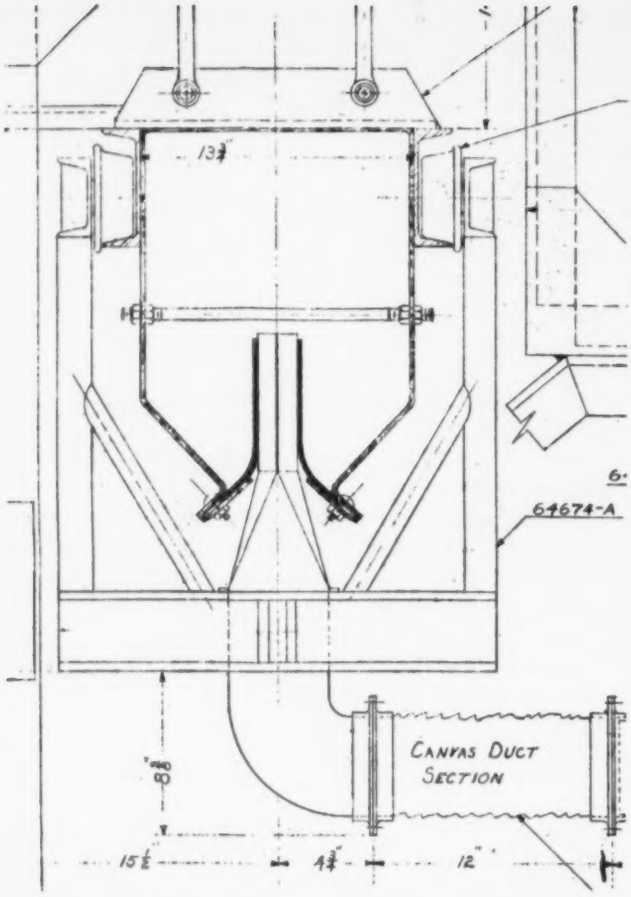


Figure 1 — Section through stationary supply duct and traveling feeder tube shows valve formed by conveyor belting in the bottom side of the duct.

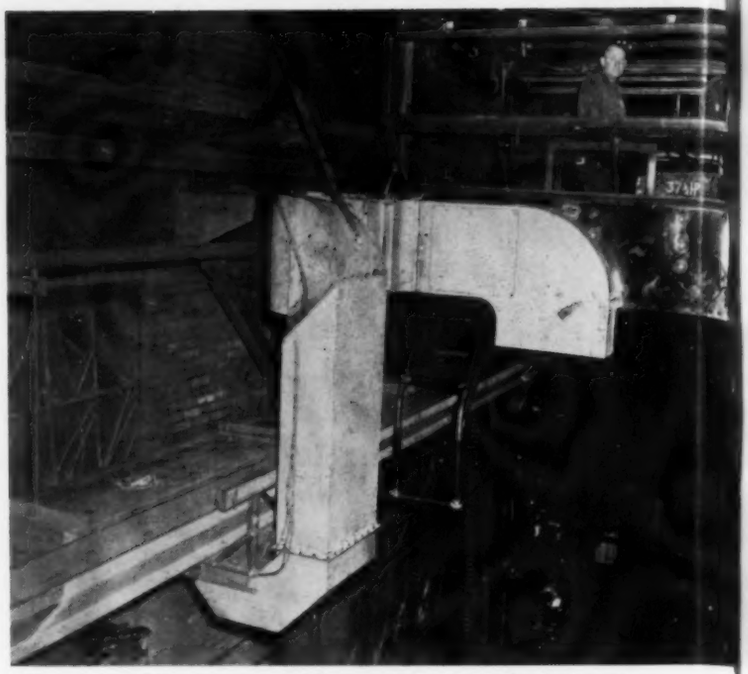


Figure 2 — View shows stationary duct, feeder tube attached to the crane cab, and the trolley arrangement for supporting the feeder tube in position at the stationary duct.

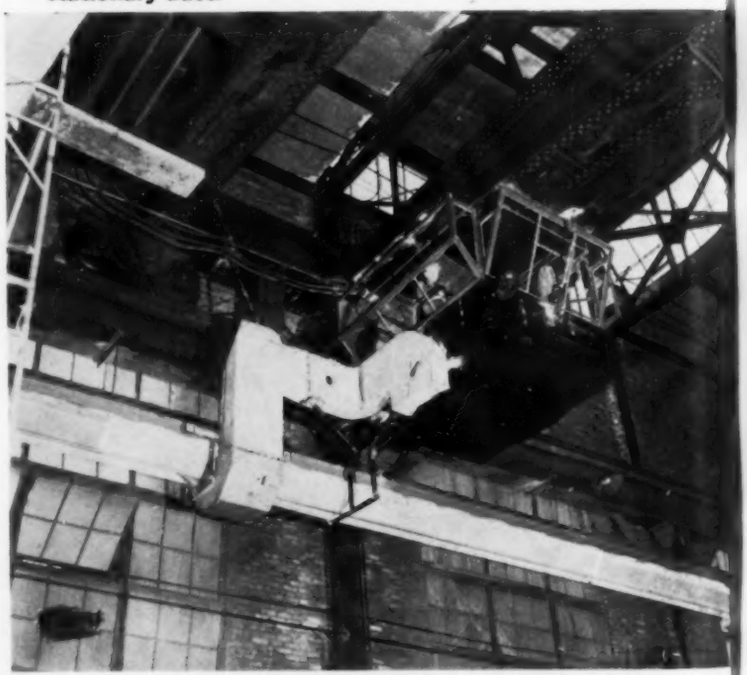


Figure 3 — View shows the stationary duct, the feeder tube attached to the crane cab, and the trolley arrangement for supporting the feeder tube in position at the main duct.

closed position at all times by the nature of its construction, as well as by the static pressure in the duct—about 0.4 in. water gage. Attached to the cab and supported by a carriage arrangement suspended from the duct is a second duct through which air is conveyed from the stationary main supply duct to the cab. This carriage can be seen in Figures 2 and 3. By means of a streamlined nozzle which extends into the supply duct through the valve (Figure 1) air is carried to the cab continuously no matter where the crane is located in the building. With this arrangement, designated the "zipper ventilator" by those who devised it, air is supplied to the cab at a rate between 400 and 1200 cfm to suit the wishes of the crane operator. The incoming air is heated in cold weather by means of electric heaters.

This ventilating system has completely isolated the crane operator from the room atmosphere. Being supplied with outside uncontaminated air, his exposure to carbon monoxide is essentially zero, no matter how bad conditions may be in the room air at cab level. Incidentally, the cab temperature in hot weather rises only about two degrees above the outside temperature.

Dust control at ore crushing and screening operations—The operating as well as the dust control equipment for a new ore crushing and screening plant was designed by a firm of consulting engineers with long experience in the field. The local exhaust system for dust control at these operations was designed by a man well versed in the art with advice from the writer especially as to appropriate air flow rates for some of the dust sources. All dust sources, 18 in number, were tied in to a central collector and exhauster. The dust sources in the main were conveyor transfer points, material handling chutes, crushers and screens. The total exhaust rate for the system was 40,000 cfm, the air on the upstream side of the collector being handled in two mains which joined at the dust collector entrance. The calculated suction required to produce the appropriate air flow in the duct system was 4.1 in. at the entrance to the collector. Space was not available at one place to accommodate both a dust collector and

the fan so these units were located one above the other on successive floor levels, the fan being above the collector. This arrangement made it necessary to connect the dust collector and the fan by means of a pipe having a 180 degree bend. In fact, the connecting pipe was simply a U-shaped section of 42-in. diam pipe, the distance between the centerlines of the two legs being about 10½ ft.

The final plans of the dust control system were complete in every detail going so far as to show the number of sections to be used in construction of the 180 degree pipe bend. The plans were submitted to the manufacturer of the collector chosen for this system for a quotation on the collector with appropriate fan.

After the system was placed in operation, it was readily apparent that something had gone amiss because the suction at most hoods was much less than the design calculations indicated it would be. Dust control, in the main, was not bad, but it fell short of expectations. A study of the air flow in the system revealed that the total rate was only about 32,000 cfm, and the suction at the collector inlet was only 2.1 in. water gage rather than 4.1 in. as called for on the plans. Further study indicated that the trouble lay in the choice of the fan. The air flow and resistance data on the plans were simply referred by the collector manufacturer to the rating tables of a fan manufacturer, and a fan meeting these criteria was selected. No consideration apparently was given to the other factors which well might influence the performance of the fan, notwithstanding the fact that the clues were all contained in the complete design information on the plans in the possession of the collector manufacturer.

This example illustrates what probably is the most serious pitfall facing plant engineers in the design and selecting of ventilating equipment. Fan rating tables are based on test data obtained under ideal conditions. Long lengths of well-made straight ducts are employed on the inlet and discharge sides of exhaust fans when tested. Air straightening devices are located in the ducts primarily to permit convenient and accurate measurement of the rate of air flow, but these devices insure a uniform flow of air into the entire fan inlet aperture. Any variation from these ideal conditions at the exhaust fan inlet has a detrimental effect on the fan performance. Bends at fan inlets may reduce the air flow rate by as much as 20 per cent, and if the bend is badly shaped, the reduction may be even greater. Since exhaust fans for dust, gas and mist control in industry almost never have good inlet conditions, the design capacities of the system rarely will be achieved unless the fans are oversized either as to designated size or as to speed. If you want to get in any local exhaust ventilating system what you think you are buying, give careful consideration to the piping system for at least 10 pipe diameters upstream from the fan inlet, and having done your best in the layout of this pipe section, make allowances when choosing the fan for the reduction in performance that will be experienced if the approach piping section is not ideal.

Belt driven fans rather than direct connected ones provide the flexibility needed to increase the fan speed if such is found to be necessary. Obviously, the fan motor must be sized with this possibility in mind.

This might be an appropriate place to point out also that the pressure losses should be calculated carefully in all local exhaust systems so that the fan can be chosen judiciously. "Guesstimates," or values taken from a hat, as to the pressure against which the fan must operate are the best kind of insurance that your ventilating systems will not give satisfactory results. The proper fan cannot always be selected even if the best design analysis possible has been made of the system, but the chances of a successful choice are infinitely better than if a "hit or miss" approach is followed. A further precaution to observe in the selection of fans other than those having load limiting characteristics has to do with the choice of the fan motors. Since the horsepower demanded by most types of fans operating at a constant speed goes up sharply if the air flow rate increases as a result of a decrease in piping resistance, the rated horsepower of the motor always should be 10 to 20 per cent above the fan catalog requirements to prevent injury to the motor if an inspection door is left open in the piping system directly upstream from the fan, if the piping system develops a large leak at a hidden spot, or if any other change in the piping system should occur which would decrease its overall resistance substantially.

Mist control at a hot alkali cleaning tank—Local exhaust ventilation was applied at a large alkali cleaning tank (3½ ft wide by 20 ft long) in an army ordnance depot to reduce the interference with vision and the corrosion of the overhead roof trusses. Even though a tank of these dimensions requires slot-type lateral exhaust hoods along both long sides of the tank for effective control, a hood was installed along only the rear side, because it would have been difficult to run a duct to a hood along the front side and this equipment would have been a nuisance to the operators. The design exhaust rate was calculated on the basis of 150 cfm per sq ft of tank area, a satisfactory rate, but because of a bad entrance to the exhaust fan, the actual exhaust rate was only about 130 cfm per sq ft. As a result, considerable mist continued to escape from the tank along the front side, the capture being good over most of the tank because the velocity of airflow toward the exhaust hood over most of the tank was sufficient to overcome the vertical component created by the temperature of the mist, and to overcome the other disturbances common to any operation of this kind.

A study of the air velocity and direction over the tank by one of the plant engineers showed that the velocity toward the hood was above about 100 fpm over the entire area where control was effective, whereas at the front edge of the tank, the air flow was erratic as to speed and direction, and there was no measurable component toward the hood. Obviously, then if the air velocity toward the exhaust hood could be increased to about 100 fpm over the front edge of the tank, the mist rising from the tank in this area would be captured, also. It seemed to this engineer that the velocity over the front portion of the tank could be increased by increasing the velocity of air at the face of the hood and surely the easiest way to do this was to decrease the width of the slot in the hood. This was done, and to the consternation of the engineer, the mist continued to escape as before from the front portion of the tank, in fact, conditions appeared to be worse, not better.

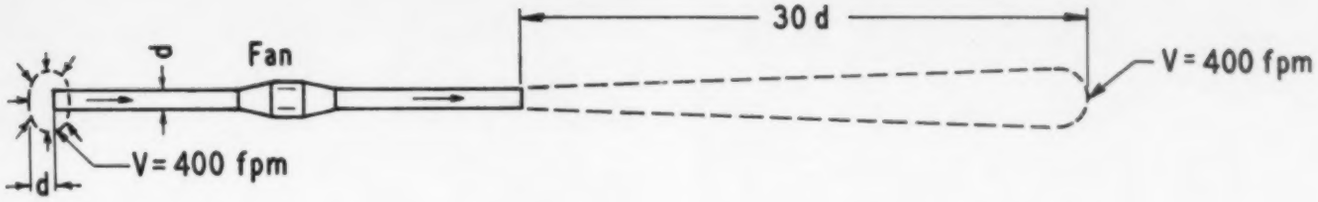
It is easy to see why there was no improvement, yet this same mistake is repeated time and time again by engineers who become so engrossed in the problem at hand as to lose sight of the basic formula describing fluid flow, namely Q=VA in which Q represents the quantity-rate of air flow (cfm), V represents the air velocity at the point in question (fpm), and A represents the area in square feet through which air is travelling at the velocity V. A and V must be measured at the same place and A must represent the surface area of the velocity contour. In this instance, the value of A had not been changed at the point where an increase in V was desired, therefore the only way V could be increased was to increase Q, a requirement not met by decreasing the slot width of the hood. In dealing with hoods under suction, one must never lose sight of the fact that air approaches any opening under suction essentially uniformily from all unobstructed directions. Thus, the shape of a velocity contour around a small diameter pipe end under suction is almost spherical, the value of A in the formula Q=VA being about $4\pi r^2$ where r is the distance from the end of the pipe to the point where V is measured [2]. Similarly, the shape of a velocity contour produced by a long slot type hood under suction is essentially cylindrical except at the ends where it becomes essentially hemispherical [3]. Because of the rapidly increasing value of A in front of most suction hoods, the velocity drops off rapidly, and for this reason, exhaust hoods do not have much "reaching-out power". Suction openings are wholly unlike pressure or supply openings in this respect, and since most engineers have had much more experience with the latter, they frequently try to apply their knowledge of the characteristics of air issuing from pipes to exhaust pipes and hoods. This, of course, is fatal as is illustrated forcibly in Figure 4. Because air in motion possesses considerable energy, a relatively high velocity can be created at some distance from the end of a pipe under pressure. To produce the same velocity in the opposite direction by placing the pipe under suction requires a tremendous exhaust rate, since the combined factors of directional velocity and inertia act entirely differently under these conditions.

Before leaving this example it may be well to indicate how the condition at the alkali tank was corrected. A baffle was erected vertically along the rear edge of the tank for a distance of about four ft. This simple and expedient change cut off all the air flow entering the slot exhaust hood from the rear of the tank, thereby decreasing the open area through which the air passed in flowing toward the hood by about 50 per cent. Since Q remained constant in the formula Q=VA, the velocity at any given point in front of the hood increased in proportion to the decrease in A, and the velocity at the front edge of the tank was doubled by the baffle at the rear. It often is possible to improve the effectiveness of a hood by installing baffles or flanges in such fashion as to cut off some of the ineffective area through which air is flowing toward the hood [2].

Cooling rolling mill motor room—To reduce the temperature in a large mill motor room in hot weather, it was decided to increase the ventilation rate through the room by about 200,000 cfm. This total amount of ventilation was to be accomplished by a number of independent supply units in order that only as much air as necessary to maintain a suitable temperature would be supplied to the room. It was decided that all of the air should be cleaned to keep maintenance of the building and equipment at a minimum. In the belief that "anything worth doing is worth doing well" the air cleaning equipment selected and installed was of the type commonly believed to be as good as any available insofar as dust separating efficiency is concerned. As with the fans, the air cleaners were sectionalized to permit supplying different rates of ventilation to the motor room depending upon the need. After installation, several changes were made to overcome apparent operating shortcomings and the final air cleaning equipment consisted of seven independent fan and cleaner units, each having a capacity of about 22,000 cfm, making a total ventilation rate of about 154,000 cfm when all units are in operation.

According to the performance data of the air cleaner manufacturer, the equipment selected would remove more than 90 per cent of the particulate matter in the air processed by these cleaners at the flow rate cited in the preceding paragraph. After the equipment had been in operation about a year, it appeared that much more dust was collecting on the walls and other surfaces of the motor room and equipment than had been expected, and a study was undertaken to determine how effectively the cleaning equipment was removing the particulate matter from the incoming air. The results of this study indicated that the cleaners were far short of the efficiency claimed by the manufacturer. Changes made upon the advice of the supplier's engineers improved the conditions substantially, but the cleaning efficiency still was far short of the goal, namely 90 per cent. The most recent study showed that it averages 80 per cent for all seven units, there being considerable variation from one unit to the other. The best unit was removing 88 per cent of the dust burden and the worst ones (two units) 76 per cent. Only two of the units exceeded 80 per cent. Since the value of air cleaning equipment must be judged not on the basis of the dust retained, but rather of the dust not retained, it is apparent that this installation is doing only half as good a job as was expected and as was claimed by the manufacturer.

It is difficult to decide where the blame for this failure lies. We feel certain that the manufacturer's claims are not unexpectedly ambitious, and that the reported cleaning efficiencies are based on accurate tests conducted by the manufacturer. The difference probably is principally one of type of dust used or encountered in the efficiency studies. The dust burden at the air inlet to this mill motor room apparently is of a type that is not readily removed by the cleaning equipment that has been installed. The poor return on ventilating installations such as this cannot and will not be avoided, until much more experience and knowhow are possessed by many more engineers in the ventilating field and in industry generally. The deplorable lack of scientific background and information in this field is admirably indicated by the foregoing example. In this instance, the selection had to be made even though little information was at hand as to how clean the treated air should be, how dirty the uncleaned



Exhausting – Approximately 10% of face velocity at one diameter away from exhaust opening.

Q in pipe = 4000 cfm
A of pipe = 1 sq. ft
V in pipe = 4000 fpm

Blowing – Approximately 10% of face velocity at 30 diameters away from blowing opening.

Figure 4 — Comparison of air flow at suction and at blowing pipe.

air was, and what were the physical and chemical characteristics of the particulate matter in the untreated air. Under circumstances such as these, and they repesent the rule, not the exception, there is little chance that good returns can be realized on ventilation investments.

It is high time that the steel industry determine by appropriate research how clean the air should be in motor rooms. Admittedly, this is not an easy undertaking, but the qualities of clean air or the parameters defining acceptable air are the only basis on which an economical selection of such cleaning equipment can be made. Needless to say, information is needed also as to the nature and concentration of air contaminants in the air to be used for motor room ventilation. Such is obtainable without great difficulty. However in the absence of all this information, it is not difficult to see why the most efficient and the most expensive cleaning equipment might be installed at a motor room, where the dust burden in the untreated air is less than that in the cleaned air at another motor room located in an area of greater pollution and served by relatively inefficient air cleaning equipment. Examples of such inconsistencies are rare but they do exist.

Heat control in a large building housing annealing furnaces—The building in question was essentially a closed steel structure, the outside walls and roof being of coated corrugated steel construction. The roof had not been provided with adequate natural draft ventilators and the outside walls contained very few openable panels or windows. Consequently the hot air produced by the furnaces rose to the roof and was unable to escape fast enough, thereby subjecting the crane operators to undesirably high temperatures.

To correct this condition it was decided to install a number of large capacity propellor exhaust fans along the ridge of the roof. In requisitioning the fans, the purchasing department was given the usual instructions to purchase a stated number of propellor type roof fans of such size, number and make, or equal. The purchasing department ordered fans of the desired capacity, but of smaller size and less cost, the specified capacity being achieved by an increase in the fan speed. When the fans were placed in operation they created so much noise at floor level that the men on the floor objected to operating more than a few at a time. Since the heat conditions at floor level never were bad and were quite acceptable with relatively few fans operating, the floor men kept turning the fans off to suit themselves. However, the fans were installed primarily for the comfort of the crane operators, and all were needed to achieve acceptable conditions in the cabs. The net result was that the fans were not operated as intended because of the noise. The nature of the building construction was partly responsible for the high noise level on the operating floor, but the real fault lay in the fan selection. If low speed fans had been chosen, this noisy condition would not have existed. It is always well to choose and specify low speed fans for roof installation to guard against objectionable noise.

Belt-driven fans are preferred to direct-connected ones because the motors are located outside the main air stream and are easier to maintain.

Roof fans for heat control—Rather than develop this subject lesson by way of an example, the general principles governing the use of such fans will be outlined. Exhaust fans on the roofs of buildings to remove the hot air that may collect at roof level serve a most useful purpose. However, to do any good at floor level, the makeup air must enter at floor level and traverse the occupied area. Since air usually takes the shortest route between its inlet to the building and the exhaust, the floor area usually is short circuited by the makeup air unless special provisions are made to prevent it. In the final analysis, roof fans per se merely remove the heated air that accumulates at the roof. If additional improvement is desired, special provision must be made for it.

With but very rare exception, roof fans cannot be counted on to overcome the effects produced by the forces of nature. Thus, such fans have no significant influence on the air pattern in a large building of average construction except on very calm days. An outside wind of only a few miles an hour will upset any air flow pattern through the building that may have been expected of the fans. Similarly, if a building housing substantial heat sources has a monitor roof, as for example, open hearth buildings, money invested in roof fans usually is a total loss, since the influence of the wind and the thermal draft drown out completely the effects of the air exhausted by roof fans at various locations on the roof.

Because of the many opposing or nullifying factors prevalent at most large mill and factory type build-

Figure 5 — Radiant heat shields are installed on the sides of and beneath a rolling mill pulpit.

ings, roof fans too frequently fall far short of expectations. Nevertheless, they sometimes serve a most useful purpose even though they may not change measurably the actual heat conditions. Many employees who are subjected to heat ask for relief. When told by their supervisors in all honesty and sincerity that they do not know what to do to improve conditions, the employee will say "why not put a fan in the roof overhead to take this heat out of here." Even though the supervisor as well as the engineering personnel consulted may know that such installation will achieve no improvement whatsoever, they realize also that to argue this point with the employee will merely serve to convince the man that the company does not want to spend the money for the fans. Consequently, for reasons of good industrial relations, the fans are ordered and installed. In instances such as this, and there are many of them, the ventilating investment may produce a very good return even though objectively the conditions have not been changed significantly.

Reference was made earlier to monitor roofs on mill buildings. The conventional style monitor roof construction is very ineffective when there is a transverse breeze having a substantial velocity component at right angles to the long dimension of the building. As the air crosses the building, it is compressed slightly on the windward side because of the roof slope. When this slightly compressed air reaches the windward opening in the monitor ventilator, it rushes into this opening, and because it now is decompressed slightly, less air goes out the lee side of the monitor opening than entered the windward side resulting in a net gain of air through the opening, rather than a loss. The heated air which is supposed to escape through the monitor is carried to the lee side of the building and frequently passes over employees enroute to openings on this side of the building. Many engineers know of buildings in which the air always is very hot on the downwind side of the building in hot weather. Properly designed roof ventilators will eliminate such conditions in most instances. Admittedly the time to correct this mistake is when the building is being constructed, because the cost of changing later is almost prohibitive.

Good results can be obtained by making provision for closing the windward side of the monitor. Movable louvres, sliding windows or hinged doors which are operated mechanically so that the windward side of the monitor is always closed and the leeward side always open, provide good ventilation at all times if the open area in the monitor is of adequate size. Manual regulation of such equipment cannot be depended upon. A simpler, though very effective, arrangement is to construct the roof with permanent windshields on both sides of the monitor in such fashion that the peak of the roof is open, the monitor portion being hidden between the wind deflectors. Such arrangement serves to deflect the wind upward as it reaches the ridge of the roof, thereby creating some suction at this opening and assisting the thermal current of the air rather than opposing it. This type roof construction is not very common, but it is becoming more so. We have often wondered why monitor roof construction is not simply reversed, that is, the cupola or monitor portion of the roof being inverted and located below the ridge of the roof rather than above it. Such arrangement, even though more difficult to construct, should accomplish good ventilation irrespective of wind direction; high wind velocity assisting rather than opposing the thermal flow of the hot air in the building.

Radiant heat control—The thermal load to which employees and equipment in the steel industry frequently are subjected includes radiant heat to some degree. In many instances, most of the heat load is radiant, and heat in this form is not amenable to control by ventilation. This is not to say that a man or equipment exposed to radiant heat cannot be cooled by ventilation, but rather that the ventilation has no effect whatsoever on the amount of radiant heat reaching the man or object. Ventilation merely serves to remove heat at an increased rate from the man by convection and by sweat evaporation, and from an object by convection, it does not decrease one iota the heat received by the man or object from the radiating surfaces. If this fundamental principle of heat transfer by radiation is always given consideration in solving heat problems, less money will be wasted on ventilation for the control of heat.

Radiant heat contributes an important part of the heat load whenever the environment feels hotter than a good mercurial thermometer indicates it should. On a more scientific basis, the radiant heat load is important whenever the globe thermometer temperature[4] exceeds the true air temperature as determined by a thermometer shielded against radiant heat. Whenever the globe thermometer reading is high and the true air temperature is not excessive, first consideration should be given to radiant heat reduction. Ventilation should be resorted to only if: the true air temperature is high and the difference between it and the globe thermometer reading is not great, and if the radiant heat load cannot be reduced effectively.

Figure 6 — Radiant heat is reduced and effective ventilation is accomplished by a double hood at a continuous rod and wire annealing furnace.

Figure 7 — Radiant heat shielding protects insulation on electrical wiring.

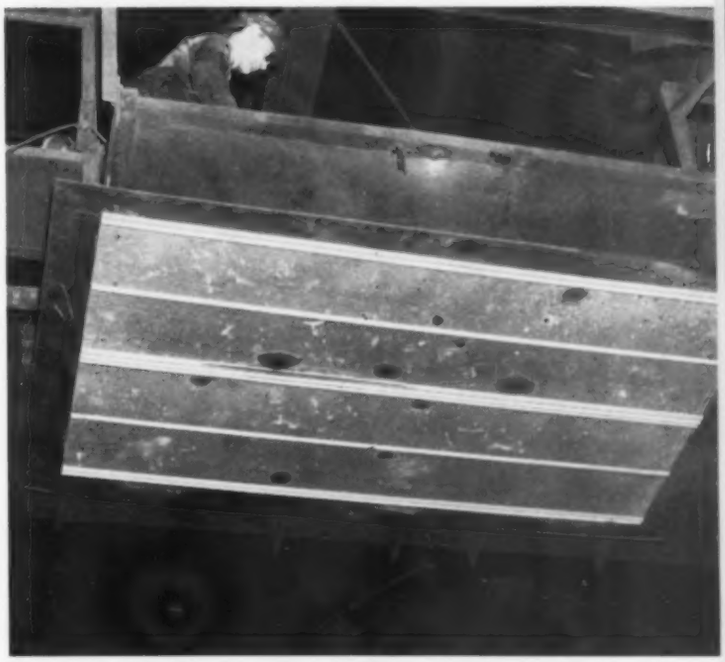


Figure 8 — Radiant heat shielding protects a hot shear crane motor.

Radiant heat shielding was not employed scientifically until recent years and even now is not used nearly as much as it might be. Any material that is opaque to infra red rays is a good primary radiant heat shield. However, most materials possess a high coefficient of absorption for infra red energy and become heated by the primary radiant heat. When they become heated, they become secondary sources of radiation, and do not reduce the load to the best advantage. Other materials such as stainless steel and aluminum have a very low absorption coefficient and reflect most of the incident infra red energy. Consequently these materials do not become heated unless in physical contact with the hot surface, and are extremely effective radiant heat shields. They have an added advantage in that they possess very low coefficients of emissivity with the result that even if they should become heated by physical contact with a hot surface, they radiate only about 5 per cent as much heat as do many other materials.

A few examples of effective radiant heat shielding are shown in Figures 5 through 8. Figure 5 shows a rolling mill pulpit where the radiant heat load has been reduced tremendously by the application of aluminum sheets on all exposed surfaces except the windows. In some instances this procedure may not eliminate the need for air conditioning, but at the very least, it decreases greatly the capacity of the cooling equipment needed.

Figure 6 shows a large hood above a continuous wire

annealing furnace. A hood was needed to control the gaseous products of combustion released by the furnace as well as the lead fume and dust escaping from the lead tank. Instead of using the conventional materials of construction, some aluminum was used to reduce the amount of heat radiated by the hood which becomes quite hot from the furnace gases rising through it. A unique feature was incorporated into this hood design to achieve effective control of the air contaminants and hot air in cold weather when the building might become air bound. The hood is constructed of double walls, only the outside ones being of aluminum. The open area between the walls connects to the outside at the roof so that the makeup air required by the heat, gas, fume and dust exhaust system can enter through it and flow across the open area between the bottom of the hood and the top of the furnace and lead tank without being heated, since it does not traverse the area occupied by employees.

Figures 7 and 8 indicate how radiant heat shielding may be employed advantageously to solve maintenance problems at equipment subjected to harmful amounts of radiant heat. Figure 7 shows aluminum that has been installed on the hot sides of electrical conduits to remove the heat load produced by the hot coils of strip stored nearby. Before the conduits were covered with aluminum, the intense heat in them caused rapid deterioration of the wire covering. Figure 8 shows an application of aluminum sheet beneath a motor on a hot shear crane to reduce motor maintenance problems. Before the radiant heat shield was installed the motors had to be removed for rewinding almost monthly, whereas such rewinding now is required only at intervals of more than a year.

One caution is in order with respect to reflective shielding for radiant heat. The shielding material acts exactly like a mirror, and if applied unwisely may create a serious radiant heat problem in an area where no heat problem existed before. All the incident heat that is not reflected directly back to the primary heat source by the shield will be reflected in other directions just as the visible light would be reflected if the shield were a mirror. This will cause trouble on occasion if it is not kept in mind during the study of the problem.

Even though application of the principles exemplified in this paper will go a long way toward eliminating common pitfalls in designing and installing ventilating equipment, the factors affecting air flow or air movement are so many and varied that the design, construction and application of any ventilating equipment deserves individual and independent thought. Simply because one system worked well at one place does not insure success at another. Stereotyped thinking must give way to individual thinking supported by fundamental principles and concepts if the ventilating investment is to produce a good return.

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DISCUSSION

PRESENTED BY

S. H. MUMMA, Superintendent Electrical Department, Bethlehem Steel Co., Steelton, Pa.

BOYD M. BIERLY, Technical Assistant, Electrical Department, Bethlehem Steel Co., Steelton, Pa.

DR. ALLEN D. BRANDT, Chief Industrial Hygiene Engineer, Bethlehem Steel Co., Bethlehem, Pa.

S. H. Mumma: The ventilation of the gas engine building crane cab was very interesting. We tried to work out a scheme of this kind for a soaking pit crane, but we ran into so many objections that we gave it up in favor of an air conditioner in each crane cab.

Dr. Brandt mentioned temperature in the crane cage was two degrees hotter than the air outside in the summer. I would like to ask how it was in the winter. That was one of the objections we thought about in the soaking pits, that it would be too cold for the operator in the winter.

Boyd M. Bierly: With respect to the gas-electric building, I would like to know the velocity of air used to insure the comfort of the men, if the air is preheated in the wintertime, and what is the position of the outlets with respect to the floor level of the building.

Dr. Allen D. Brandt: In cold weather the air supplied to the crane cab is heated by electric heaters in the cab. The air enters the cab through an expanded metal floor from a plenum beneath the floor which is fed by the nozzle or feeder duct.

The air supplied to the gas-electric building by the two large centrifugal fans is not preheated. For this reason the building becomes uncomfortably cold at times, and one of the supply fans must be shut down. The air should be heated, and would have to be in a colder climate to prevent having the fans out of operation much of the time. I do not know the velocity of the air through the floor gratings, but this is not critical in this instance, because there is little if any need for the building occupants to be in the draft that might exist. The outlets are in the roof about 40 ft above the floor. The air enters the building proper through the gratings in the floor and for the most part rises to the roof to escape. Some of it probably escapes through doors and windows in the building walls.

Member: Is there any reason for bringing the air up through the floor of the crane cab?

Dr. Allen D. Brandt: There is no compelling reason. It happened to be more convenient to do so in this instance. In addition, there is evidence showing that persons are less sensitive to off-temperature air striking their legs than their heads and faces.

By WILLIAM C. WHITMORE, Supervisor Electrical Maintenance, Alan Wood Steel Co., Conshohocken, Pa.

Productive and Preventive Maintenance of finishing mills

. . . . maintenance methods are essential to starting up and maintaining new equipment . . . . actual applications of these methods and their utilization in training a maintenance force are covered . . . .

▲ DURING the period of two years from January of 1953 to January of 1955, the total electrical connected load of the finishing department increased by 866 per cent. This increase in load was brought about by the installation of a 26-in., 300-fpm continuous pickle line in the hot strip finishing department, and the installation of a completely new cold roll department, consisting of a four-stand, 12-in. and 33-in. x 32-in. tandem mill, 21 single stack annealing bases, a single stand 22-in. x 32-in. two-high temper mill, a 26-in. pull-through slitting line, a 26-in. cut-to-length line, and various other finishing and auxiliary units. This equipment, being new in sequence of operation and design, presented the maintenance department with the problem of developing and training a mechanical and electrical force for the maintenance of this equipment, and with establishing maintenance methods to be applied to the equipment. It has been experienced that productive and preventive maintenance methods can be applied very successfully utilizing a maintenance force which has been trained in why and how the equipment operates. Consequently, the maintenance applied to the expanded finishing department has revolved around training and application, not just application alone. This paper is concerned primarily with the development of several maintenance methods and the utilization of these methods as a training medium.

Maintenance at all times must be ready to cope with the breakdown situation. However, if the scopes of productive and preventive maintenance methods are kept in mind as the breakdown situations are remedied, then these situations will become the exception rather than the rule. Concurrently, maintenance will resolve into two methods and their combinations. Strictly speaking, and individually, they may be defined as follows:

1. Productive maintenance methods are those which eliminate any possibility of a production non-scheduled down-time. These methods are concerned with the productive aspects of a department.
2. Preventive maintenance methods are those which reduce the possibility of a production non-scheduled down-time. These methods are concerned with the maintenance aspects of a department.

These methods applied individually are rarely realized and consequently, refinements and combinations were employed and utilized in the training of the maintenance force assigned to maintain the expanded finishing department.

In selecting men for maintenance training on the new equipment, men were sought who had good basic maintenance qualities and a background which would enable them to comprehend the circuit designs to be encountered. In the existing hot strip finishing department, there was a maintenance force of motor inspectors who had been instructed in some of the theory and equipment to be encountered in the expanded department. Their background qualified them for maintenance training for the new equipment. Throughout the plant in other departments, were motor inspectors who had performed qualified work. All of these men were thoroughly acquainted with all phases of crane, constant-potential circuitry and general motor maintenance, but they were not acquainted with the many and varied phases of work to be performed on the new equipment. Due to the requisite of continued performance, the motor inspectors in the hot strip finishing department were assigned to the maintenance of the new pickle line in their department, and individual motor inspectors from the other departments were assigned to the maintenance of the cold roll department. These selected men, together with the assigned production supervisors, were instructed by the manufacturer in a series of study and field classes on the theory and operating technicalities, and were given the opportunity to view the construction and installation while in progress. The majority of their training however has occurred since the start-up of the equipment.

While individual pieces of equipment must be assigned their own maintenance programs according to their operation and design, the need is apparent for productive and preventive programs which cover a

EQUIPMENT PART NUMBER & DESCRIPTION: BRIDGE DRIVE — CRANE NO. 69

WORK REQUEST NO.: 80075

COST CODES FOR WORK REQUEST: 6-401-659-2/4-01-69

TYPE OF MOTOR AND SPECIAL REMARKS: GENERAL ELECTRIC MD 610 AE 230 VOLTS D.C. SPDC-AISE 10-50-2 100

TO MEGGER REMOVE 4 MOTOR WIRES FROM BACK OF PANEL-MEGGER TO GROUND

TO GREASE USE AW NO. 4 GREASE (SHELL ALVANIA NO. 2)

ACTION CODE: I — INSPECTION; RA — REPLACE ARMATURE; RM — REPLACE MOTOR

SCHEDULE CLERK COMPLETE THESE COLUMNS | FOREMAN COMPLETE THESE COLUMNS. USE CHECKS (✓) FOR ACTIONS TAKEN & RECOMMENDED. FOR MORE SPACE FOR REMARKS USE NEXT LINE OR LINES WRITING COMPLETELY ACROSS CARD.

DATE SENT TO FOREMAN	ACTION SCHEDULED I	ACTION SCHEDULED RA	ACTION SCHEDULED RM	DATE OF ACTION BY FOREMAN	ACTION TAKEN I	ACTION TAKEN RA	ACTION TAKEN RM	DETAILED REMARKS REGARDING ACTIONS TAKEN & RECOMMENDED. FOR REPLACEMENTS BE SURE TO LIST A.W. NUMBERS OF MOTOR OR ARMATURE REMOVED AND INSTALLED.	NEXT ACTION RECOMMEND I	NEXT ACTION RECOMMEND RA	NEXT ACTION RECOMMEND RM	NO. OF TURNS TO NEXT ACTION
				9-4-55	✓			AW 1650 GREASED – BRUSHES & COMMUTATOR CHECKED – MEGGERED ARM. AT 950,000 OHMS & FLD. AT 900,000 OHMS.	✓			525
				9-18-55	✓			AW 1650 DISCONNECTED MOTOR WIRES AT PANEL- OPENED MOTOR & CLEANED WITH AIR & CLOTH – MEGGERED FLD. AT 15 MEGOHMS & ARM. AT 3 MEGOHMS	✓			258
12-12-55	✓											

Figure 1 — Field card contains information on the equipment.

complete department or plant. Throughout the plant and in the expanded finishing department, a motor-generator preventive program is in operation. Although most of the finishing department rotating machines are relatively new, this program has been in operation since the start-up of the department for a case history is essential to the successful operation of such a program.

All of the motors and generators have been assigned a number and have been divided into categories and integrated into the plan indexing of motors and generators. Each motor or generator is assigned a field card and a file card which are processed by a clerk, working with a plant index. A typical field card is shown in Figure 1. This card contains information pertaining to the department the drive is used in, the line or mill it is used on, and the specific piece of equipment it is driving. An electrical coding for the drive is on the card according to its nameplate data, and this information along with its number on the card, indexes it in the plant filing system. A work request number and cost code are listed on the card, by which all charges against the drive can be made and eventually tabulated and recorded. All of the aforementioned information is permanently recorded on both cards. Each drive was considered for importance and application and accordingly was assigned instructions as to cleaning, greasing, meggering, brush and commutator or slip ring inspection. The field card which is kept in the mill while the drives are being serviced contains information as to what maintenance is being done on the drive. It is this information which will change from time to time and gradually develop into the history of the motor or generator.

To initially start the program, the field cards were initiated in the mill, and each card was filled in with maintenance instructions according to its location, condition and location of its control devices, circuitry, and hours of operation. Greasing practices and brush-commutator-slip ring inspections and maintenance were established according to the manufacturer's recommendations and knowledge gained by our own experience. Meggering instructions were varied to give as desired a history as possible without disconnecting each motor at its terminals. It was decided that small alternating and direct-current motors and generators could be meggered directly from their control panel with as many panel devices as possible isolated from the circuit to be meggered. Exceptions to this rule were small drives subjected to adverse conditions. Such machines were to be disconnected at their terminals. Large motors and generators were to be disconnected at their terminals regardless of operating conditions. Since all of the large machines concerned had copper bus connections, opening points in the bus were determined and labeled so that all meggering in the future would be done from these points.

With all of the maintenance to be performed on the drives established, the problem of when to start the program confronted us. With such a large number of motors and generators to be serviced, the program would take too long if done piecemeal and would be too expensive if performed all at once. It was finally decided that one line or mill at a time would be undertaken during a reasonable weekend shutdown. This was desirable for it gave the force ample time to perform and understand the work and it also established that all of the drives on a line or mill would have the same number of turns operated and would be scheduled together for the next servicing. As the program developed, the field cards were given to the men who performed the work and they in turn indicated on the card that the work was performed. The cards were then sent to the plant clerk with the number of turns

of operation indicated before the next servicing was required. The clerk will automatically return the cards to the mill several weeks before the next servicing is due.

This motor-generator preventive program has only been in operation a short period of time, with the first servicing occurring nine months ago, so it is too early to ascertain concrete results. Several benefits were derived, however, so that it is expected in the future, greater benefits will be realized. There are six identical 65-hp, 230-volt, 445-rpm series-wound motors on the hot strip finishing department's 10-ton, 81-ft, 4-in. span overhead cranes. Two of these motors are installed on each crane for hoist and bridge service and all had been in service the same amount of time. Four of the armatures were meggered at 20 megohms, while one was meggered at 450,000 ohms and the other at 175,000 ohms. The series field values of the two motors were also correspondingly low. These motors with the low readings were opened and cleaned out thoroughly until the armatures meggered at 3 megohms and the field at 15 megohms. They have been closely watched since and have shown no appreciable change. On the four-stand tandem mill are three tensiometer adjusting motors. These motors were used briefly during the start-up for setting the tensiometer rolls in relation to the pass line and had only been used sparingly thereafter. During the meggering of these motors, it was discovered that each was grounded, due to the mill sprays saturating them. These motors were repaired with the production department suffering no inconvenience.

The installation of the cold mill department and the pickle line required the installation of a 6900-volt power system with its associated switchgear and 440-volt load centers. A single line diagram of the 6900-volt and 440-volt power systems is shown in Figure 2. Power distribution units of this type were new to the maintenance force, for initially only 440-volt power was used in the finishing department and that was obtained through units in the hot strip rolling department which were maintained by a different maintenance force. To train the maintenance force for maintenance of this equipment, the experience of the manufacturer was initially utilized. One of their representatives conducted classes explaining the switching of the circuits and associated theory. He then held field classes using the breakers for illustrating purposes. The 7500-volt, 1200-amp, 3-phase air-circuit breakers were thoroughly reviewed with demonstrations of linkage, puffer action and barrier removal. Racking procedures were demonstrated and the interchangeability of breakers was stressed. The effects of the racking action on the cubicle shutters and the cell switches were demonstrated and the effects produced by these components when the breaker was not racked in properly were illustrated. One of the most important demonstrations was that concerning the parts of the breaker which were at line potential when the breaker was in operation. These parts and their associated barriers are red, and this factor is extremely helpful from a safety standpoint and in understanding the breaker. The smaller 440-volt load center air-circuit breakers were reviewed in a similar manner.

With the physical operation and purpose of the breakers established, the electrical operation of the

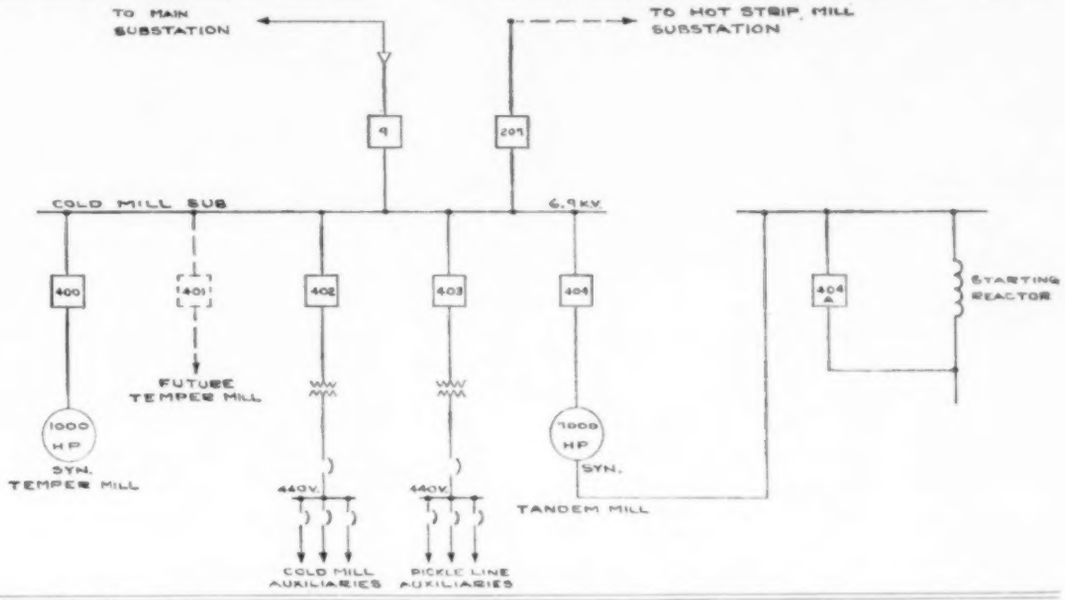
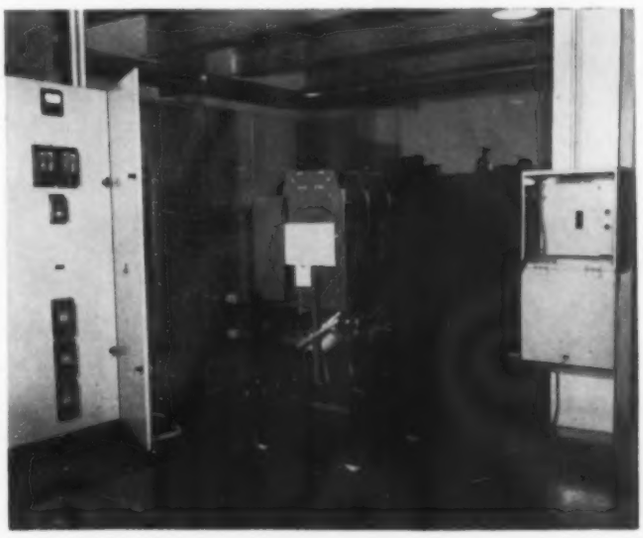


Figure 2 — Single line diagram of cold mill power system.

Figure 3 — The 7500-volt breaker for the tandem mill motor-generator set has been pulled out and connected to the test rack.

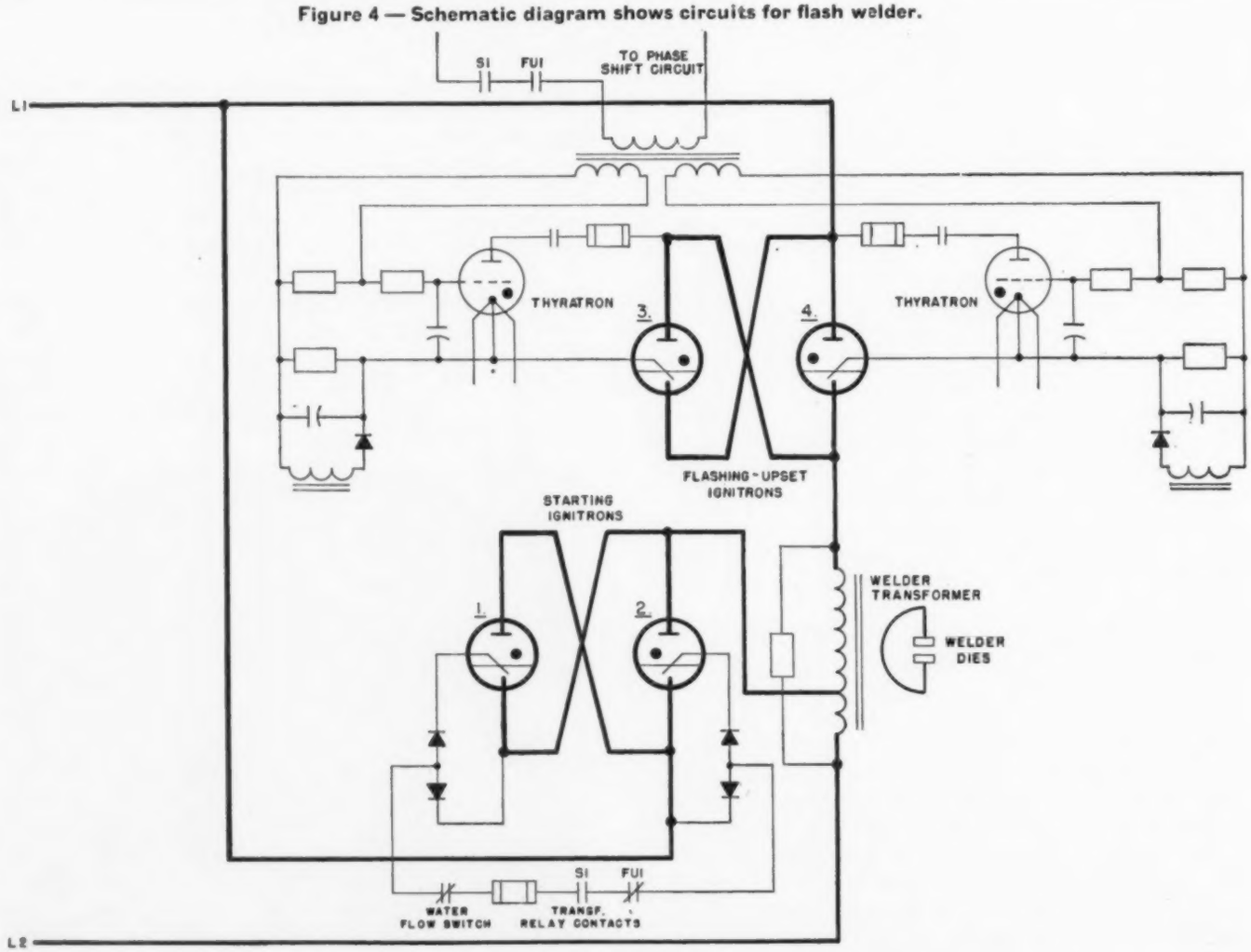


7500-volt and 440-volt main breakers was undertaken. This program was divided into two parts, the breaker circuits and the cubicle circuits external to the breaker. By connecting the 7500-volt breakers to the test panel and coordinating the operation of the breaker with the schematic drawings, much information was conveyed to the maintenance force. The cubicle circuits were likewise demonstrated with emphasis on the purpose and operation of the fault relays.

A preventive program was established for the maintenance of this power distribution equipment. This program was developed on the basis of cleanliness, understanding of electrical and mechanical operation and good maintenance practices. Shown in Figure 3 is the tandem mill motor-generator set 7500-volt breaker, racked-out and connected to the test rack. At a scheduled convenient time each circuit breaker is removed from its cubicle and thoroughly cleaned. The barriers are removed and the mechanical and electrical components examined. The breaker is then connected to the test rack and operated several times so that the linkages, contacts, and puffers can be observed operating. In the cubicle the shutter, cell switches and auxiliary close-trip relays are inspected. The breaker is then racked-in to the open position. The control switches for operation of the breaker are inspected, cleaned, and tried for correct sequence of operation. The breaker is then closed and tripped to be sure it is in condition for the next start-up. The same procedure is followed for the 440-volt load-center breakers, except that the main breakers which are electrically operated do not have a test rack. All of the 440-volt breakers are operated by hand, for inspection purposes, after they have been racked-out on rails.

A condition requiring a combination of productive and preventive maintenance methods was experienced with the electrical equipment for the pickle line flash welder. The purpose of the welder is to weld the trailing edge of one coil to the lead edge of another coil. This is done by employing the elements of time, pressure and heat. A change in any one of these elements, while the other two are held constant, will seriously affect the composition of the weld. Essential components of the heat circuit are the starting and flashing-upset ignitrons and their thryratron fired igniter circuits. These components are indicated schematically in Figure 4. Basically, the electrical operation is, as follows: The starting ignitrons are ignited by transfer relays closing in their igniter circuit and the transformer becomes energized applying a starting voltage on the welder dies. After a selected period of time, the transfer relays open the igniter circuit of the starting ignitrons and close the igniter circuits of the flashing-upset ignitrons. The transformer is again energized and applys a flashing voltage on the welder dies. After a short selected time interval, the excitation of the transformer is changed and an upset voltage is applied to the dies.

Figure 4 — Schematic diagram shows circuits for flash welder.



Several months after start-up, trouble was observed in the welding operation by two significant facts, these being substantial transformer humming and erratic ignitron glow. After considerable trouble-shooting of the phase-shift and igniter circuits, it was found that conditions in the igniter circuits of the ignitron tubes were responsible for these faults. Initially, it was found that the igniters of the ignitron tubes were burning open, resulting in a non-firing or hard-starting condition which caused a pulsating direct-current flow in the transformer. Each ignitron of the igniter in the mercury pool was resulting in a deterioration of the igniter, with the result being a continual decrease in the contact area between the igniter and the mercury pool. Consequently, a troublesome ignitron was caused by a burning open of the contact area between the igniter and the mercury pool. It was found that the degree of this contact could be predicted by measuring its resistance with an ohmeter connected across the igniter and cathode of the tube. To determine the degree of this contact, new ignitrons were measured and found to average one hundred ohms. The igniter resistance of several tubes that fired erratically or not at all, was measured and found to be between five and twenty ohms, or infinity, if the contact area was open. On this basis, a preventive program was established by which the igniter resistance of the ignitron tube was measured periodically and recorded. When the resistance was found to be around ten ohms, the tubes were replaced. This program, however, was not completely satisfactory for it soon became apparent that a tube measured on one shutdown and still meeting the established igniter resistance requirements would not necessarily last until the next shutdown measurements were scheduled. On this basis, a productive maintenance program was established whereby any tube with an igniter resistance between twenty and thirty ohms was replaced. This program has been in service for a little more than a year with no production down-time due to ignitron tube failure.

Such a circuit as shown in Figure 4, was completely new to the maintenance force responsible for the maintenance of this equipment. In the training of this force, rules were established for trouble-shooting the welder circuit which not only helped during a breakdown but gave insights into the operation of the circuits. These rules were established for expediency in trouble-shooting after the normal circuit elements and the igniter resistances had been checked. For the starting ignitrons, a rule was established that if neither tube glowed, the trouble lay in their contact-fuse-flow switch circuit. At the same time, it was also established that if only one ignitron glowed, the trouble lay in the non-firing tube's rectifier. Several similar rules were established for trouble-shooting the flashing-upset ignitron circuits. If both tubes indicated trouble, the trouble was ascertained to be in the phase shift circuit, for this circuit is common to both igniter circuits. If only one ignitron indicated trouble, the rule was established to interchange the thyratron tubes. If the symptoms transferred from one ignitron to the other, the thyratron was replaced. If, during this interchange, the trouble did not transfer, it was established then that the trouble lay in the thyratron bias circuit. Experience has proven that these rules are so reliable that the maintenance force now uses them as their starting medium for trouble-shooting. One of the most important aspects of these roles is that they have also exposed the important components of the circuit and it is these which the maintenance force concentrates upon during normal preventive maintenance.

Figure 5 — The pickle line loop control system makes use of magnetic amplifiers.

While the welder was introducing to the maintenance force, ignitrons and thyratrons, the pickle line loop control system was introducing magnetic amplifiers for the first time. In establishing a means of instructing and training the force for maintenance of this equipment, it was decided to first indoctrinate them on the basis of how the system works and its purpose in terms of physical components. Physically the system consists of two pinch roll motors, a magnetic pick-up unit mounted in the bottom of the entry tank, a magnetic amplifier control panel, a rotating amplifier and a boost-buck generator. It was illustrated that the object of this equipment was to maintain a constant length of material between the two pinch rolls and that the pinch rolls performed this function on the basis of the height of the strip in the tank above the pick-up unit. Proof was furnished by the loop position meters and observance of the strip performance in the entry tank. With the purpose of physical operation thoroughly understood, an explanation of the electrical devices and circuits was undertaken. These devices consisted of the entry and delivery pinch roll tachometers with their stabilizing speed signals, the magnetic pick-up unit with its strip height signal, the magnetic amplifier for rectifying, amplifying and signaling the rotating amplifier, and the amplifier with its various fields and output to the boost-buck generator. Shown in Figure 5 is a portion of the aforementioned electrical equipment.

To explain the operation of these devices, the meters contained in the magnetic amplier control panel were invaluable. With a physical knowledge of what was happening out in the tank, the men were able to associate the meter readings with the strip position. Each phase of the circuit was explained and verified by the meters. Such constant conditions as a delivery tachom-

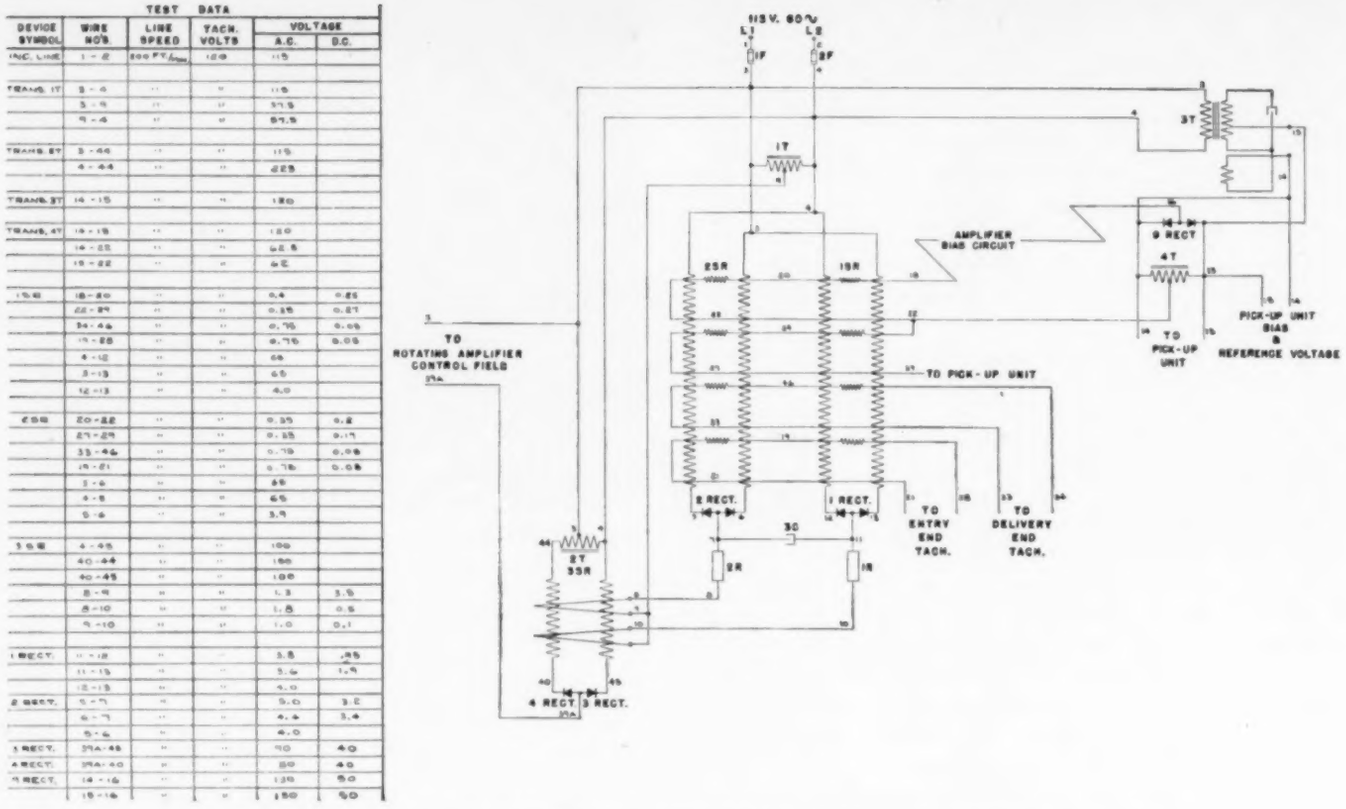


Figure 6 — Schematic diagram of pickle line loop control transformer and saturable reactor circuit.

eter signal, amplifier bias, and a pick-up bias were pointed out, while at the same time such varying conditions as, amplifier field current and entry end tachometer signals were understood, for their effect on the end result, the boost-buck generator voltage could be observed.

An explanation of the circuitry and the maintenance of the equipment were combined into one scheme, for it was realized that even though the force had a working knowledge of how the equipment should operate and respond, there was still the problem of how to train them to trouble-shoot the devices and circuits they determined as not operating properly. The main concern was the magnetic amplifier control panel. To solve this problem, the engineering department compiled voltage data at all beneficial circuit points and at specified operating speeds. This data was listed on a drawing with the complete schematic of the system and any manufacturers' notes determined important. A portion of this data and the circuits concerned are shown in Figure 6. These deal with the constant voltage transformers, rectifiers, and saturable reactors. With this data, a preventive program was established whereby at a time when the line was running at the specified speed shown on the drawing, the data compiled was verified by the maintenance force actually taking voltage readings. This program, it is felt, has been immensely helpful in training the force to understand the magnetic amplifiers and become familiar with the circuits. While the program has been in effect for one and one-half years, the production department has not lost any time as a result of the failure of the parts combining to make up the magnetic amplifier control panel. Shortly after start-up, some breakdowns did occur due to pinch roll conditions, iron oxide in the entry pick-up tank and improper settings of the pinch roll motor field rheostats. These conditions were rectified and while they were harmful to production they did tend to acquaint the maintenance force with the operation of the system.

Spare parts are an essential factor in the operation of productive and preventive maintenance programs. However, from a maintenance standpoint, new equipment offers a challenge as to what spare parts should be obtained. Familiarity with the wear, design and operation of a piece of equipment is essential for spare part determination, and since this essential factor is missing during a start-up of new equipment, some parts are invariably overlooked. It is then that all of the resources of a maintenance department are combined to their utmost to remedy the breakdown situation. In this case the training which has been expounded for maintenance becomes invaluable. Such a case prevailed several months after our start-up concerning the 400-cycle generator supplying power to the magnetic amplifiers for the 22-in. x 32-in. two-high temper mill. This 30-kva, 220-volt, 3-phase, 3600-rpm generator suddenly and without warning stopped generating. An investigation showed that its drive motor had shut down due to an overload. During a preliminary investigation, it was found that the generator's outboard bearing was extremely warm. The end bell of the generator was removed, exposing a sealed ball bearing that was completely ruined. Spare bearings had not yet been ordered and since the temper mill was operating at 20 turns, we were on the verge of a costly breakdown. A check of all the possible bearing substitutes available in the plant was made and a suitable bearing

was located. This bearing was installed in the generator and the mill was started up after several hours downtime. After the generator was running, it was checked for vibration. It was found that the vibration in the machine was in excess of 0.003 in. Since this was the case, it was realized that the bearing might fail again and it would be necessary to prevent another lengthy shutdown. The idea was developed to power the temper mill magnetic amplifiers from the tandem mill 400-cycle generator if another emergency occurred. It was ascertained that the voltage and frequencies of the two systems were the same and that phasing was no important. The load was determined, and three over size cables were run for 200 ft through the oil cellar and wind tunnels, and connected so that the tandem mill 400-cycle generator could supply power to the temper mill magnetic amplifiers, if so required. At the same time, preparations were made for the manufacturer to dynamic balance the rotor and install new bearings at the first opportune time, but it was realized that the time required would extend beyond the next scheduled shutdown period of the mill. Consequently, the idea of powering both 400-cycle magnetic amplifier systems from the tandem mill 400-cycle generator was fully developed. During the shutdown for the removal of the generator, the two systems were connected in parallel. The two mills were started up, and the load on the tandem mill 400-cycle generator observed until the most severe loadings had occurred. As previous calculations and data had indicated, the maximum load on the generator never exceeded 90 per cent. The mills were operated in this temporary condition for two weeks with excellent results.

In reviewing the new equipment encountered, perhaps the most interesting and challenging has been the magnetic amplifiers installed in the tandem and temper mill exciting and regulating circuits. Prior to our start-up, classes were conducted by the manufacturer regarding their construction, theory, operation, and maintenance. We were familiar with rotating and electronic amplifiers but we had never operated and maintained a large number of magnetic amplifiers.

All of the magnetic amplifiers are single-phase units connected in combinations for single-phase and three-phase full wave rectification. These variable impedances are mounted on asbestos panels in ventilated enclosed cabinets. A typical magnetic amplifier panel is shown in Figure 7. These panels have front and back hinged doors. For the tandem mill there is a panel for the 400-cycle generator, for each of the stands and the winding reel. For the temper mill there is a panel for the winding reel and a combined panel for the drag reel and the 400-cycle generator. The magnetic amplifiers are mounted on the front of the panels towards the bottom. Their associated transformers and rectifiers are mounted on the back of the panel towards the bottom. On the front of the panels, towards the top, are located all of the associated meters. From a maintenance standpoint, the construction of these panels is excellent, for every piece of equipment is accessible, grouped and identified. Each panel is ventilated by an exhaust fan mounted in its top.

Shortly after start-up, the magnetic amplifiers were

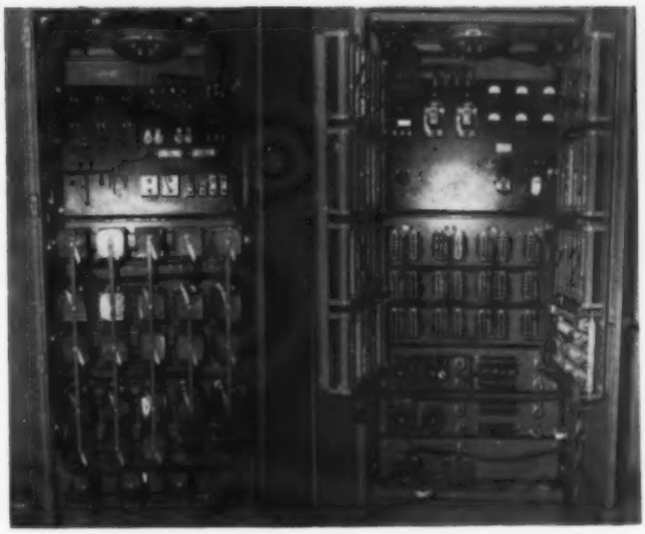


Figure 7 — Typical magnetic amplifier panel has back and front hinged door. Figure shows both sides of same panel.

reviewed for the purpose of establishing maintenance methods for them. It was realized that the absence of rotating and moving parts practically reduced their maintenance to ventilation, cleaning, and observation. It was also realized that this lack of required maintenance might lull us into a false sense of security. We wanted to be prepared for the first breakdown and consequently we decided to record as much operating data as was practical. All of the bias meters were observed, and after several weeks these constant values were painted directly on the case of the meter. We were now able to detect a lost or changed bias on any magnetic amplifier. The engineering department has developed detailed data by measuring and recording voltage data for different operating speeds and loads including jog and idle run operations. It is felt that in the event of a breakdown, we will be able to simulate one of these conditions and utilize the data in determining the trouble.

Preventive maintenance methods have been established for the magnetic amplifiers which are applied entirely while the units are operating. They are checked each day for ventilation and abnormal heat dissipation. At the same time, the bias readings are checked against the standard painted on the meter case. During periodic shutdowns, they are vacuum cleaned and their connections tightened. Training has occurred since start-up because of its necessary value in maintaining these magnetic amplifiers. Classes have been conducted with the equipment and drawings side-by-side. Although it is too early to predict the results of these ideas, no magnetic amplifier breakdowns have occurred during the first year of operation. The temper mill systems have been especially satisfactory in view of the 20 and 21-turn operation the mill has been undergoing since start-up.

Of all the equipment encountered in a finishing department, overhead cranes require the utmost in productive and preventive maintenance, for their operations are essential to a continuous material flow and high production. Consequently, good maintenance methods must be employed to their fullest extent. To

successfully execute such maintenance, it is necessary that potential crane failures be reported in sufficient time to prevent a breakdown. Many of these potential failures can be accounted for during the normal shutdown maintenance applications, while some can only be detected while the equipment is operating. Therefore, maintenance methods must be utilized while the equipment is running, as well as when it is down. The available sources for potential failure reports are the operators and the maintenance forces assigned to the equipment while it is running. In the hot strip finishing department, it was found that the operators and the maintenance force were very reliable and conscientious in reporting potential failures, if they were trained and given a working knowledge of how the equipment should operate.

As mentioned earlier, all of the maintenance men assigned to the maintenance of the finishing department were familiar with crane maintenance and therefore, we were concerned not with training but with application of previously proven and new maintenance methods. Maintenance is performed on the cranes while they are operating by utilizing available periods of time when the cranes are not actually in operation. This is not enough time to thoroughly maintain the cranes, and consequently, only the troublesome items are handled during these short periods, while the more extensive repairs are undertaken during a scheduled shutdown. Each turn the crane is operating, the maintenance force goes on the cranes during available periods to check and make small repairs on parts which invariably wear or break. They also note larger parts for wear and possible failure and report on their longevity of operation. It is these reports which are the backbone of the maintenance program for the majority of crane failures occur quickly after the cause occurs. During scheduled shutdowns, more extensive preventive repairs are undertaken on the basis of daily preventive reports. Likewise productive maintenance repairs are undertaken during scheduled shutdowns, if it is doubtful that the item will not operate until the next scheduled shutdown.

While the value of methods and training in executing good maintenance has been discussed with respect to electrical equipment, it has also been experienced that the value can be obtained with respect to mechanical and hydraulic equipment. Many of the mechanical start-up problems were analyzed and solved by the mechanical force, in a manner similar to that employed by the electrical force. The millwrights obtained for the maintenance force in the expanded finishing department were obtained in a manner similar to that described for the motor inspectors. Much of the equipment was new to them and training was ascertained as very important in developing maintenance methods for them to apply.

An important part of the mechanical maintenance in which training has been expounded heavily is in the assembly and disassembly of the temper mill work rolls and the tandem mill back-up roll tapered roller bearings and chucks. These were new to the force and consequently each bearing mechanic and millwright was thoroughly trained under the supervision of the manufacturer and our supervisors. Each of these men had performed work on the rolls several times by the time they were required to perform prescribed maintenance work. At all times we insist upon clean work and we are constantly striving to improve our roll shop maintenance. We have experienced that all work on our rolls requires the utmost in good preventive maintenance and consequently, we have continually been training and demonstrating the correct aspects of this work.

The pickle line flash welder served as an example of the values to be obtained from training and the application of productive and preventive maintenance methods. Shortly after the electrical troubles with the welder were corrected, we experienced the condition of not being able to make consistently good welds. The welder was thoroughly examined with the end result being that not one big item but a number of small and seemingly immaterial items were contributing to our poor welding operation. Several of these items were the die surfaces, the platen movement, and the hydraulic pressure. It was found that the condition of the surface of the dies was extremely important for uniform and consistent welding. We were using the dies for too long a period and in the process of machining them in our machine shop, we were not obtaining a desirable surface. We now productively maintain our dies by utilizing one set of dies for no longer than twenty turns of operation, although they could possibly be used longer. When a new set of dies are installed, the greatest care is taken to make sure they are seated properly. After seating them, they are levelled and an imprint test is made to determine the condition of the die surface. It is this test which taught us the value of perfect die surfaces. Since we have utilized productive maintenance in changing the dies and preventive maintenance in installing them, we have greatly improved our welding operation. Two other factors which are essential to good welding are the platen movement and the hydraulic pressure applied to the platen. Up to the time of our troubles, we had not been especially concerned with our hydraulic pressures. The manufacturer assisted us in analyzing the pressures applied to the platen for flashing-upset and recommended that we install an additional accumulator to insure a good pressure during upset. We also installed pressure gages at all critical points in the hydraulic system for observation during the welding operation. The maintenance force and the operators have been instructed as to what values the meters should indicate. They observe them while the welder is operating and report potential trouble and failures. These reports have been very important and we utilize them in our productive and preventive maintenance. We have experienced that the quality of these reports improved as our training improved and expanded.

In the foregoing paragraphs, productive and preventive maintenance has been defined and applications to some finishing department equipment have been discussed. Singularly, the aforementioned methods are rarely realized in actual applications and it is their combinations which are most frequently applied, resulting in normal maintenance. However, their mean-

ing can be appreciated singularly because productive maintenance insures continuity of operation and preventive maintenance stabilizes and reduces maintenance costs.

DISCUSSION

PRESENTED BY

L. V. BLACK, Superintendent, Electrical Department, Bethlehem Steel Co., Bethlehem, Pa.

H. H. ANGEL, Electrical Engineer, Bethlehem Steel Co., Bethlehem, Pa.

CHARLES BOYLE, General Foreman, Electrical Mechanical Maintenance, Bethlehem Steel Co., Bethlehem, Pa.

WILLIAM C. WHITMORE, Supervisor Electrical Maintenance, Alan Wood Steel Co., Conshohocken, Pa.

L. V. Black: I would like to ask Mr. Whitmore for a little more information concerning the number of clerks or personnel necessary to maintain his index card system. I understand there is one card for the office file, and a second, which is a duplicate, is given to men in the field several weeks before that piece of equipment comes up for maintenance. When that card, in the field, is returned to the office, will all the information be put on the office card so that on subsequent returns to the field, the field man will have a knowledge of all previous maintenance work performed?

We, at Bethlehem, have a different preventive maintenance system in each one of our divisions. Each works with a varying degree of success. We are now making a study to see whether one system can be adapted to the benefit of the entire plant. Bethlehem plant is a specialty plant composed of foundries, forges, machine shops, rolling mills, and heat treatment departments, so that preventive maintenance does become quite a problem.

The system used in our power group is crude, but works very successfully, and requires no additional help. Each piece of electrical equipment, or power equipment, has a file card in a maintenance file. Today's card is given to the maintenance men, they write on the card what they found wrong, and what they did to correct it, and return the card to the foreman, who inserts it in the file at the proper place for subsequent maintenance. If the apparatus calls for weekly maintenance, the card is put in the file so that it will be front card in a week. Same procedure is used for units requiring monthy or yearly maintenance. Each morning when the foreman looks over his cards, he knows what is ahead of him for that day, and assigns the cards for that day.

H. H. Angel: I started to work in the steel industry a little over 35 years ago and was taught then the importance of continuity of power and operations. It is stressed more today, especially since processes are apt to be more continuous and more complications result from interruptions. I believe that in some cases the metallurgy of the steel is affected upon failure to maintain continuous operations.

Mr. Whitmore has mentioned the preparations they have made in training men. We cannot get away from the fact that we do have complicated equipment in use today, and it will be even more so as automation increases. When equipment breaks down, you just cannot have fellows wondering what it is all about. The training should enable the maintenance men to do a better job.

Mr. Whitmore stated that the men were asked to take instrument readings in the regulating circuit controls during normal operations in order to detect any changes which might indicate that trouble is developing. This is a very important planned maintenance item. Many organizations probably have employed this practice in the past. It is hoped it will be followed more closely.

Charles Boyle: I have a question that concerns force and work assignments. Is your productive and preventive maintenance program handled by the normal force assigned to a maintenance area or have you a group of motor inspectors trained as specialists and assigned as a separate force to follow only the productive and preventive maintenance program?

William C. Whitmore: As to the number of clerks necessary to maintain our index card system for our motors and generators, we have two clerks to perform the necessary clerical work. The mill clerk processes the cards while the machines are being serviced and the plant clerk processes them between servicing periods. The file card will always be in the plant index for plant records, while the field card will be in the motor inspectors possession during the servicing and in the plant index between servicing periods.

As far as the information on the cards is concerned, the information is put on the field card at the time the machine is serviced by the motor inspector doing the work. Consequently, the information concerning each servicing will be indicated on the card, and the motor inspector servicing the machine will have before him a complete record of the machines maintenance, both present and past.

I would like to thank Mr. Angel for his comments. I agree with him that as the aspects of automation increase, we will have to strive to improve our maintenance methods. As I mentioned earlier, it has been my experience that maintenance can be performed successfully by men who have been trained in why and how the equipment operates. I believe this to be true regardless of how complicated the equipment may be. Consequently, one of the best ways to keep up with automation is to keep up with your training.

In answer to Mr. Boyle, who asked a question about the maintenance force, I would like to say that the type of maintenance work I have described is being performed by motor inspectors assigned for normal department maintenance. They are a young group of men who we have been training continuously on the job and we hope that they will become specialists.

We feel that with the coming of this new equipment, as complicated as it is, each motor inspector must be trained to become a specialist. We are developing maintenance methods and training the men at the same time, and we feel that eventually it is going to result in better maintenance.

Central maintenance shops provide an organization for efficiently doing jobs which can be best handled by a central group . . . . it provides also a pool for handling large emergency departmental jobs . . . . maintenance costs are competitive with the best experience in the corporation.

Central Maintenance Operations and Control at Fairless Works

By ROY L. LEVENTRY
Division Superintendent
Maintenance and Utilities
Fairless Works
United States Steel Corp.
Fairless Hills, Pa.

▲ THE central maintenance shops building at Fairless Works is centrally located with respect to the producing divisions drawing the most heavily on the available services. (See Figure 1.) These divisions are the rolling, sheet and tin, and open hearth. Located close to the central shops, in another building, are the diesel locomotive, railroad car repair and mobile equipment repair shops.

Figure 2 shows the front view of the central maintenance shops building.

The central maintenance shops building (Figure 3) is 292 ft wide and 772 ft long and is divided into three equal bays, running the length of the building. Railroad tracks enter each bay at the south end and there are also nine road entrances for trucks. Transfer cars are used for interbay conveyance.

Housed in this building on the ground floor, which has approximately 225,000 sq ft of floor space, are the various shops, employing skilled journeymen. In the east bay are located the forge, weld, rigger, boiler, sheet metal, pipe, paint and carpenter shops. Crane service for these shops is provided by one 60-ton and one 40-ton overhead crane. In the west bay are located the machine and electric shops. The machine shop is serviced by one 60-ton and one 40-ton crane and the electric shop by one 15-ton crane.

In the center bay is a large storage area of approximately 53,000 sq ft. Crane service is provided by one 60-ton crane. Large mechanical and electrical spares such as motors, crane wheel assemblies, special pipe, steel gears, line shafts, motor armatures, motor coils, cable, etc., which cannot be readily stored in the various divisions or would be damaged by the weather if outside, are stored in this area.

At the far end of the center bay are modern shower and locker room facilities (Figure 4) for the use of the journeymen in the central maintenance shops. In this locker room are approximately five hundred lockers, ten wash stands, and ten shower stalls. Space is also provided for additional lockers. Tile walls, slope-top lockers and combination ventilating-heating ducts with steam radiators at floor level provide pleasant conditions. Additional shower, locker and toilet facilities are avaliable on the second floor for office personnel.

Above the locker room, on the second floor level, are located the superintendents and staff offices for the central maintenance and utilities division. These include offices for accounting, technical, training, industrial relations, shops planning, and safety personnel. The individual shop foremen's offices are located at ground level in their respective shop areas.

The machine shop (Figure 5) is located in the western bay of the central maintenance shops building and occupies some 60,000 sq ft of floor space. In this area are located most of the machine tools used for maintenance work.

The central maintenance machine shop has machine tools to handle all the machine shop work required at the Fairless Works, with a few exceptions. The purchase of milling type planers and gear cutting machines was not economically justified since such tools would be used frequently, and outside shops are readily available for these infrequent services.

In the machine shop (Figure 6), the machine tools are grouped to permit maximum shop efficiency and safety.

The assembly area has some 10,000 sq ft of floor space. Here several pieces of equipment may be dis-

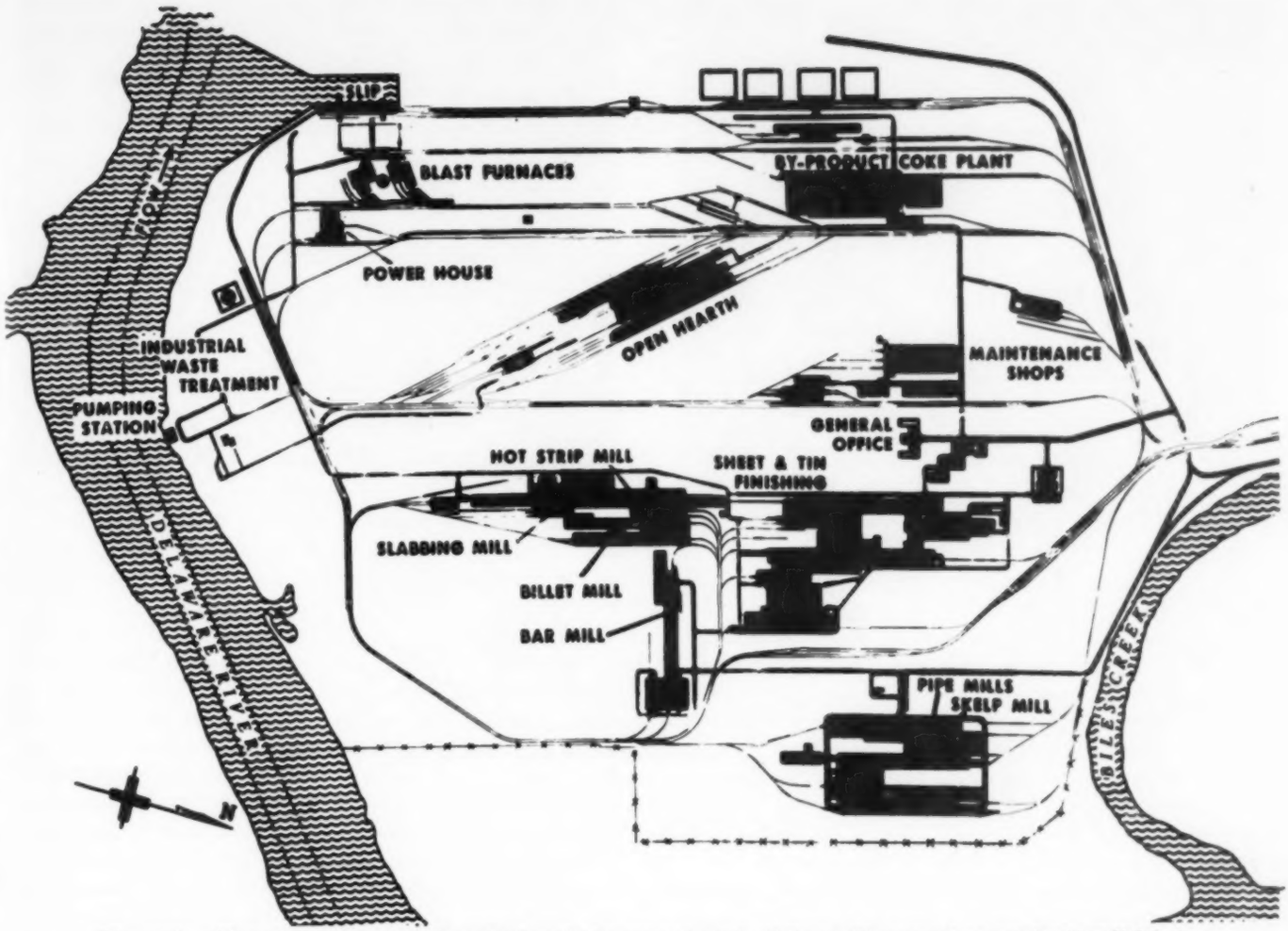


Figure 1 — Plan shows location of central maintenance shops building with respect to producing divisions.

mantled or assembled at the same time and the parts kept together, while defective piece replacements are being made.

Located in close proximity to the assembly area are those machine tools frequently needed for fitting work. These consist of a 600-ton hydraulic wheel press, ram and planer type shapers, key seater, pedestal grinders, drill presses, a saw and filing machine.

In the machine shop tool crib, are located the precision machine tools used for toolmaking and reconditioning such as a surface grinder, drill grinder, carbide tool grinder, drill press, chip breaker grinder, and tool and cutter grinder. A tool loan system is used to keep an accurate record and inventory of tools, jigs, etc., in the tool room.

The turret and smaller engine lathes are arranged along one wall. The turret lathes range in size from 23 to 28½ in. swing diam, with a maximum barstock

Figure 2 — Front entrance of central maintenance shops building is shown.

Figure 3 — Layout shows division of plant's floor space for various shops.

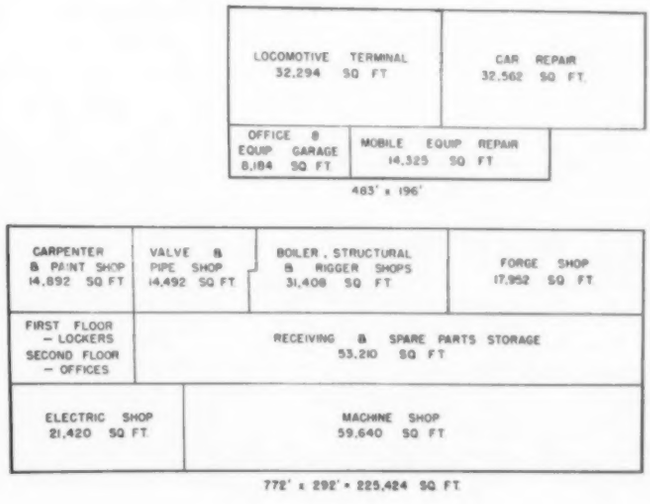


Figure 4 — Modern shower and locker room facilities are provided for journeymen in the shops.

Figure 5 — Machine shop occupies approximately 60,000 sq. ft of floor space.

capacity of 12 in. The smaller engine lathes range in size from 16 to 27 in. swing diam.

The turret and engine lathes were installed at an angle to give maximum working and feeding area and also to make for best utilization of floor space.

The need for overhead crane utilization was greatly reduced by installing jib cranes to service these smaller machine tools. These jib cranes have a positioning feature which keeps the crane boom at the same angle as the lathes to facilitate transfer, initial positioning of the piece, or its removal from the lathe.

Grinding operations are performed on four grinders located at one end of the shop, and so turned as to minimize the danger due to flying sparks. These consist of a 48-in. rotary grinder, two surface grinders and a 12 by 48-in. cylindrical grinder.

Located in the southwest section of the machine shop are the heavy duty engine lathes, two vertical boring mills, two horizontal boring mills and three large planers. The largest engine lathe has a swing of 60 in. with provisions for raising to accommodate 96 in. The horizontal boring mill has an 8-in. spindle and a vertical clearance of 98-in. The largest planer is 8 ft by 8 ft with a 30-ft table.

The experience, to date, has shown that the versatility and sizes of machine tools selected have made the necessity for sending pieces to outside shops very infrequent.

The larger machine tools, being located at one end of the shop, confine the heavy lifts for cumbersome repair jobs to one area.

In addition, the rolling division and sheet and tin division have in their respective areas the roll grinding and blasting equipment needed for roll surfacing. These machine tools were decentrally located in order to minimize the time required for resurfacing or conditioning. Roll neck bearing disassembly and reassembly is also done in these same shops. In addition, the sheet and tin roll shop has a limited selection of lathes, drill presses, and special grinding equipment to handle locally the majority of their routine and specialty type machine shop work.

Many electrical services are available through the central maintenance electric shop. The shop groups are divided as follows: line and wire, test and communications, crane repair, scales and refrigeration, and motor repair. In general, rewinding is kept to a minimum. Stator, armature, large coil and magnet rewinding is done in local repair shops. This eliminates the maintenance of a copper inventory, the purchase of special forming and winding machines, and irregular manpower demands. Our service and cost to date for

Figure 6 — Grouping of machine tools gives maximum efficiency and safety.

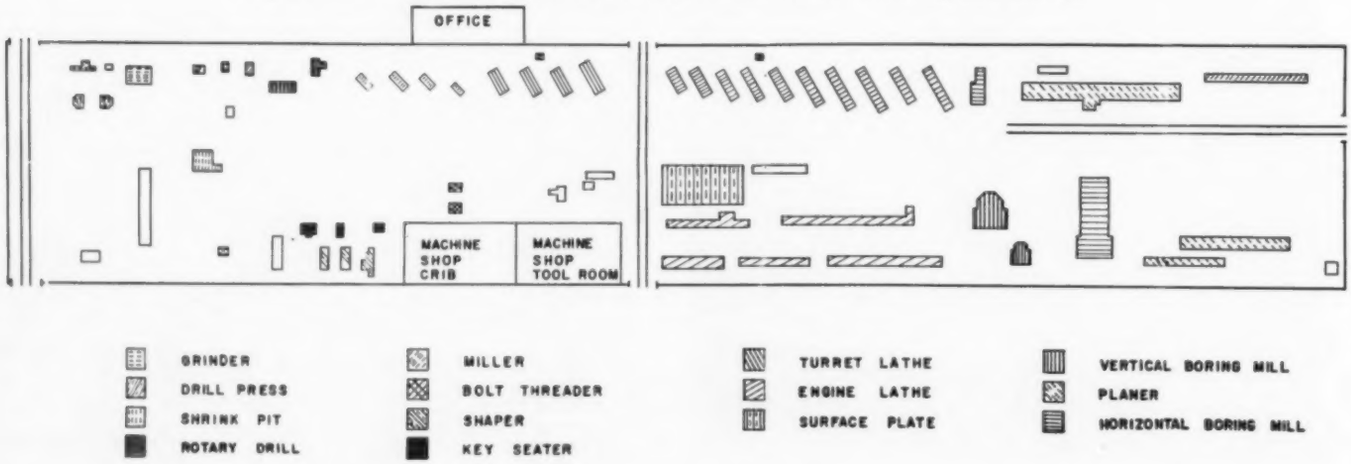


Figure 7 — View shows relay and instrument test panel.

Figure 8 — Two repair pits are provided for servicing locomotives.

this work has been quite satisfactory.

Perhaps our most diversified electric shop group is the test and communications shop. This group repairs and tests switchgear protective relays and instruments of all types. Other work, such as the initiation and continuance of a corrosion test program on ground beds, vibration analysis, plant instrumentation and control on many production units is also done by the test and communications shop.

Figure 7 is a view of the relay and instrument test panel. Adequate lighting, cleanliness, and separation from the repair floor proper are in accordance with good plant practices.

The line and wire shop has a fully equipped line truck for substation work and cable pulling needs, test equipment for power factor testing, and complete facilities for overhauling mercury arc rectifiers.

The crane repair shop is responsible for rendering repair service, as ordered by the operating divisions, to the 168 overhead cranes in the Fairless works. Their equipment includes tools necessary for repairing cranes of all capacities up to and including large 450-ton ladle cranes.

The central maintenance weld shop is diversified to many types of welding fabrication and metal restoration. Welding types available are electric arc, acetylene, inert gas, automatic and semi-automatic submerged arc, thermit welding and metalizing. Other equipment in the weld shop includes three partially enclosed welding booths with 3-ton hoists, adjustable motorized welding positioners, a multiple torch flame cutter, and a 48-in. swing lathe for submerged arc welding.

The building up of grooves in brass guides used on cold reduction mills, with phos-copper, is one of the many routine jobs handled on a continuing basis.

All forging work is concentrated in a limited area. Four jib cranes service the stress relieving, tempering and annealing ovens, the 25-ton press, and the forge hammer. The hammer is large enough to handle up to 13-in. sq material and provide a blow of 13,500 lb. This is the focal point of the operation.

Special tools available are the flame hardening machine which will treat stock up to 18-in. diam and 12 in. long, a 2400-F high heat furnace, and a 600-gal water-cooled oil quenching tank. One repetitive type operation, such as stopper rod fabrication, is processed through a three-stage die and conveyor set-up, for ease of handling and safety.

Wood fabrication and boat repair requirements at Fairless works are quite large. To accommodate these demands, the carpenter shop is operated on full turn coverage.

Lumber is stored on the second floor directly above the machine area. Thus, the lumber may be kept out of the weather and is handled by an electric hoist.

A sawdust collecting system is included at all machines which transports the sawdust to a collecting bin for easy removal.

Spray painting is done in a well lighted, ventilated booth located in a room adjacent to the woodworking machine floor where sign painting, parts painting, and other similar work are away from the dust. Large unit painting is done on the job site.

Rigger shop services are generally of a field nature and performed away from the central maintenance shops with the open hearth and rolling division receiving most of the rigging manhours.

The structural shop is composed of a sheet metal and boiler shop. Normal demands for cabinets, ductwork, signs, brackets, etc., up to $\frac{1}{8}$ in. thick are made by the sheet metal workers. Shop boilermakers have equipment to roll steel up to 2-in. thickness, shear to $\frac{3}{4}$-in. thickness, punch steel up to 1-in. thickness, and shear angles up to 8 x 8 x $\frac{3}{4}$ in.

The bulk of the pipe shop work is the maintenance of existing mill piping. A variety of pumps, ranging from $1\frac{1}{2}$-in. to 10-in. discharge, along with various other equipment are stored and maintained for immediate use in the pipe shop area. This shop area also includes bending tables for pipe fabrication and a valve repair crib for the repairing and testing of small valves.

As mentioned previously, the diesel electric locomotive, car repair, mobile equipment repair shops and the general services' facilities are housed in a building separate from the central shops building. This building measures 483 x 196 ft and affords a floor area of approximately 88,000 sq ft.

Figure 9 — Jacking pit is equipped with four 35-ton jacks to raise locomotives for truck removal.

Facilities of the diesel electric locomotive repair shop are unusually complete in scope. Services available include a crankcase oil change, or a complete rebuild from the wheels to the top of the cab.

Two repair pits (Figure 8), such as the one shown, are provided for servicing four locomotives simultaneously. All periodic inspections are scheduled for and handled on this inspection pit.

Major repair jobs are handled in the "jacking" pit (Figure 9). This pit is equipped with four 35-ton jacks which allow the locomotive to be raised to permit truck removal. The four jacks operate together with their travel automatically equalized.

The inspection and jacking pits are well-lighted, adequately ventilated, and designed to provide a comfortable work area for the mechanics. Pit facilities include compressed air taps, welding machine outlets and a centralized oil system for draining and filling locomotive crankcases.

To aid in inspection and tune up work, a resistor bank (Figure 10) with several steps of resistance may be substituted for the truck drive motors. By loading the diesel electric unit with fixed steps of resistance, the output and control devices may be accurately checked.

Overhead crane service for the locomotive and car repair shops is provided by one 75-ton and one 15-ton crane.

Other auxiliary facilities of the locomotive repair shop include a laboratory for periodic analysis of water in the lube oil, an air brake repair shop with complete testing facilities, and centrifugal filter cleaning equipment. A degreaser for parts cleaning, steam cleaning apparatus for cleaning the cab, engine, and exterior of the locomotive, and complete electrical parts repair service are also provided. Fuel injectors and injector systems are repaired and tested in a specially equipped shop.

The car repair shop facilities include a car side straightener, and necessary tools and equipment to effect complete rebuilds of all rolling stock.

Figure 11 shows one of the redesigned cars currently used to receive and carry the crop ends from slabs.

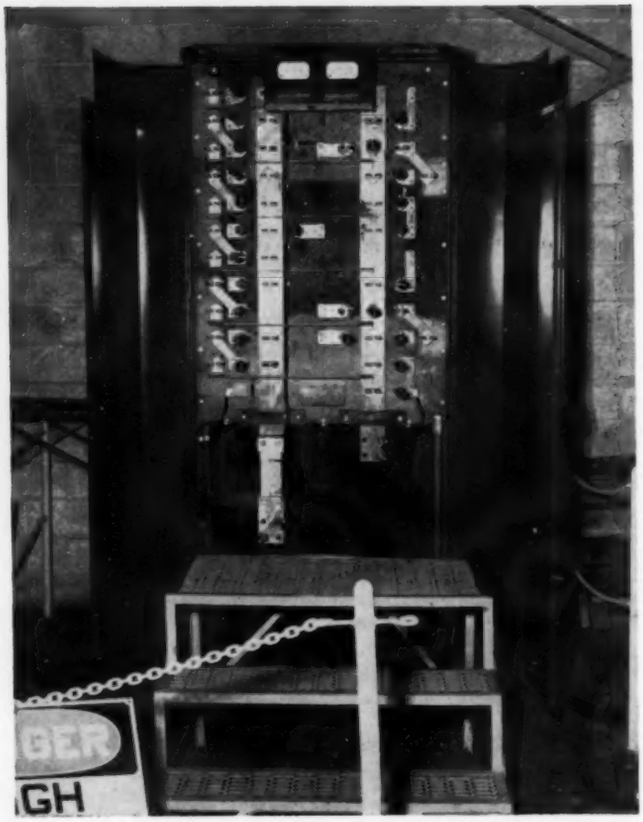


Figure 10 — Resistor bank with several steps of resistance may be substituted for truck drive motors as an aid in inspection and tune-up work.

Having been completely rebuilt and reinforced, this car need no longer visit the car side straightener.

The mobile equipment repair shop is the other shop housed in this building devoted to the maintenance and repair of transportation equipment.

This shop is charged with the responsibility of repairing and maintaining more than 200 pieces of mobile equipment. These vehicles range in size and type from a one-man scooter up to and including 15-ton material carriers.

Complete repair service for gasoline, electric and diesel-powered equipment is available on a round-the-clock basis. Services performed include tire repair, lubrication, motor analysis, ignition tune-up, washing, steam cleaning, and repair or replacement of motors.

Figure 11 — A redesigned car is used to receive and carry the crop ends from slab; construction of car eliminates need for car side straightener.

Being located adjacent to the central shops building, the tradesmen and services of the central shops are available to the transportation repair shops.

The ages of the skilled workmen in the central shops vary from 22 to 57 years. A projection of our craft personnel requirements, based on anticipated retirement and expansion, indicated that an early initiation of an apprentice training program was necessary. The apprenticeship program, followed at the Fairless Works, schedules approximately 10 per cent of the apprentices' time to technical instruction and the other 90 per cent to shop instruction and field assignments.

Technical instruction is given by the central shops staff personnel. A very comprehensive outline is followed which was established by closely coordinating the efforts of both the training department and the central shops supervision in order to cover fully the skills needed for the various tradesmen.

Recently, the first group of apprentices, comprising 14 men, who had transferred from other United States Steel Corp. plants, completed their apprenticeship training course and are working as journeymen.

A shops planning group was organized at Fairless Works to perform the services of planning, scheduling, expediting the job orders through the central maintenance shops. This group has relieved the foremen of many routine details, allowing him more time to develop more efficient shop practices.

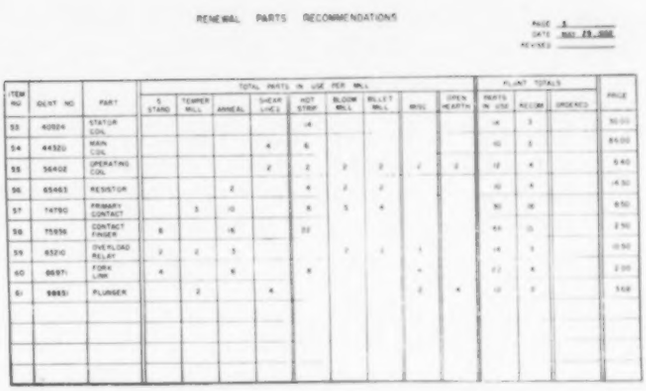
Available to the central maintenance shops and various producing divisions is a technical staff consisting of a coordinator, mechanical engineer, lubrication engineer and two electrical engineers. Working closely with the various shops, this group is able to clarify the work, furnish information to all maintenance groups, study troublesome spots, channel revisions to the engineering department, prepare sketches, initiate and follow programs, and develop ideas.

A project typical of those handled by the technical staff has been to work with the electrical equipment suppliers in tabulating and presenting in bound form spare parts summaries for the whole plant.

A sample electrical spare parts tabulation sheet is shown in Figure 12. The parts are tabulated per operating unit and the units grouped by divisions. Such a summary serves as a ready catalog and reference to all maintenance departments and the central storeroom. By considering the complete picture, stocking can be kept to a minimum and, in emergencies, any departmental maintenance foreman can readily ascertain where duplicate equipment may exist. The purchase and installation of the equipment at relatively the same time presented a wonderful opportunity for such surveys and full advantage was taken of the opportunity. As new equipment is installed, the tabulations are being revised so that they will remain current.

Another function of the technical staff is the development and coordination of various preventive maintenance programs. The plant lubrication prgram is thus a responsibility of this group.

Development of a plant lubricant procurement schedule, preparation of lubrication charts for production and service equipment, assisting in the training of personnel and assisting in laboratory tests and field



RENEWAL PARTS RECOMMENDATIONS

ITEM NO	QUANT NO	PART	TOTAL PARTS IN USE PER MILL: 5 STAND	TEMPER MILL	ANNEAL	SHEAR LINES	HOT STRIP	BLOOM MILL	BILLET MILL	MISC	OPEN HEARTH	PLANT TOTALS: PARTS IN USE	RECOM	ORDERED	PRICE
53	40824	STATOR COIL					14					14	3		50.00
54	44320	MAIN COIL				4	6					10	3		84.00
55	56402	OPERATING COIL				2	2	2	2	2	2	12	4		6.40
56	65463	RESISTOR			2		4	2	2			10	4		14.50
57	74790	PRIMARY CONTACT		3	10		8	5	4			30	10		6.50
58	75856	CONTACT FINGER	8		16		22					46	12		2.50
59	65210	OVERLOAD RELAY	2	2	3			2	2	2		14	3		12.50
60	06971	FORK LINK	4		6		8			4		22	4		2.00
61	98851	PLUNGER		2		4				2	4	12	3		5.00

Figure 12 — The manner of tabulating and summarizing parts serves as a ready catalog and reference to maintenance departments and central storeroom.

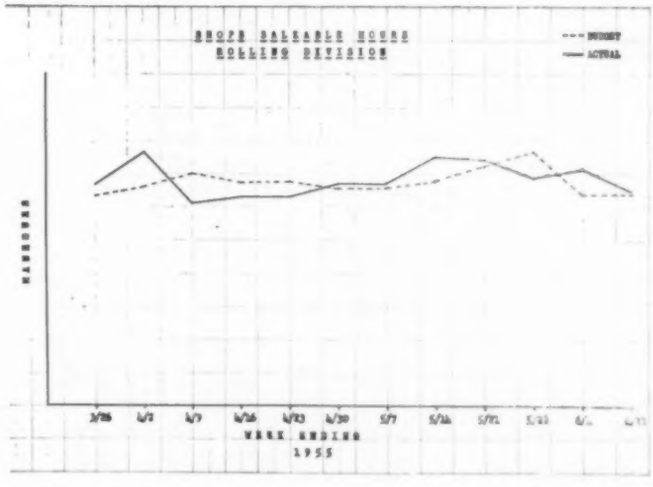
development of new products offered by lubricant suppliers are some of the duties assigned the lubrication engineer.

A project now in progress of development by the mechanical engineer is the conversion of mobile equipment to the use of propane gas as a motor fuel. This study will encompass the testing, performance, cost, safety, maintenance, etc., to evaluate the results and govern future purchases and conversions. The mechanical engineer's studies of repetitive failures have led to design improvements on mill equipment, to reduce the frequency of repair. Also modifications to consumable parts have reduced machining or fabrication time in the shops.

Working closely with the technical staff is a metallurgical engineer specializing in maintenance problems. All failures on shafts, gears, pinions, rolls, bearings, etc., are analyzed jointly by the metallurgist, shop foreman and mechanical engineer. Many changes in metals and machining have been made and coordinated through the joint efforts of these people.

Supplementing the plant trainee program is a cooperative student program which has proven quite successful and is still expanding. College students in many schools are available to industry, after their first year, on a combined work and study basis. Such school courses are for a five-year period, during which the

Figure 13 — Chart shows budget hours and actual hours charged to the rolling mill division for a 3-month period.



students alternate on either a three or six months' basis. At the present time, the Fairless Works retains twelve engineering students from three schools. These students vary in class standing and work under the technical staff. As the students progress, they are able to handle projects with less guidance and gain a degree of self confidence which helps to develop the leadership qualities needed in management personnel.

Previous sections of this paper described the shop facilities, apprentice program, associated shop and staff group function, and the student cooperative program available for maintenance demands. All these forces aline their efforts toward increased shop efficiencies and reduced plant maintenance costs.

The maintenance responsibility at the Fairless Works was established on a decentralized basis, to the end that the various operating divisions have complete control over all factors affecting their costs. Each operating or producing division has its own maintenance and repair crews consisting of motor inspectors and millwrights, unattached to the central maintenance organization. Thus, the control of maintenance expenditures is primarily the responsibility of the operating divisions.

The central maintenance organization is charged with the responsibility of supplying efficient service "on demand" from the operating divisions and charges to them must be commensurate with their earned maintenance hours. Cost of maintenance at Fairless Works is adapted to this principle.

How well the central shops have been able to discharge their responsibility of providing service on demand in line with earned maintenance hours is shown on Figure 13, which shows budget hours and actual hours charged to the rolling division for a three-month period.

With the aid of the cost and other staff groups mentioned previously, the central maintenance organization has been able to fulfill efficiently its service responsibility to the Fairless Works.

Of interest might be the method used at the Fairless Works for determining the original maintenance crew sizes.

During the construction of the Fairless Works, maintenance charges both in manhours and dollars were obtained for the most comparable units in the corporation. These were compared with the corporation standards, and a total maintenance cost, per ton of product, was developed for the Fairless facilities. This was established to the end that the Fairless maintenance cost was competitive with the best corporation experience.

The operating maintenance crews were then deducted from the total maintenance forces in order to establish the forces available for the central maintenance shops. This central shop force was then distributed to the various shops on the basis of the experience of similar corporation installations and specific Fairless Works requirements.

After operating experience had been gained and analyzed, the maintenance forces were reviewed and necessary changes made in the distribution of personnel to provide a balanced labor and cost control.

DISCUSSION

PRESENTED BY

CHARLES N. FENDRICH, Assistant Superintendent-Power and Maintenance, Bethlehem Steel Co., Steelton, Pa.

ROY L. LEVENTRY, Division Superintendent, Maintenance and Utilities, Fairless Works, United States Steel Corp., Fairless Hills, Pa

W. C. SCHULZ, Superintendent, General Mechanical Department, Bethlehem Steel Co., Steelton, Pa.

JOHN F. O'HEAR, General Foreman — Maintenance, Bar & Billet, Fairless Works, United States Steel Corp., Fairless Hills, Pa.

C. E. PRITCHARD, Superintendent of Mills, Alan Wood Steel Co., Conshohocken, Pa.

C. J. BOYLE, General Foreman, Electrical Mechanical Maintenance, Bethlehem Steel Co., Bethlehem Plant, Bethlehem, Pa.

F. L. WISE, Maintenance Superintendent, Bethlehem Steel Co., Saucon Division, Bethlehem, Pa.

CHARLES W. DUNN, Supervisor — Equipment Installation, Fairless Works, United States Steel Corp., Fairless Hills, Pa.

Charles N. Fendrich: I would like to ask a question on Figure 13. If we have so many hundred hours budgeted for maintenance and the work as it comes up during the month would exceed that budget if you did all of it, do you hold off on it and try to catch up in other months or do you do the work as it comes up, even if you exceed budgeted hours?

Roy L. Leventry: The central shops people are normally distributed, based on the earned hours, to perform the work requested by shop order from the various divisions. Each division attempts to schedule their work requirements to keep the hours per week at an even amount and within their budget.

If the need for additional hours arises, the manhours used may or may not exceed the earned hours of that division, depending upon the need for other work already scheduled.

W. C. Schulz: In these forces in the various operating departments, who hires them and assigns them? The departments themselves or the central maintenance people?

Roy L. Leventry: We have in each of our operating divisions, either general foremen or superintendents of operating maintenance. The personnel for the operating divisions are hired and assigned by these supervisors. These maintenance groups are completely disassociated from the central shops organization. Their personnel are comprised primarily of motor inspectors and millwrights whose duties are to handle the routine maintenance repair and replacement work associated with their respective operating units.

Member: What we wanted to know is how do you supplement the forces in case you have a deficiency in forces? I think you did go through that just a short time ago when you did put on additional people.

Roy L. Leventry: In case of normal deficiencies cre-

ated by either a turnover of personnel or an increased level of operation which is constant, the central shops forces are increased a comparable amount. If we have temporary deficiencies, due to emergencies, which would create a situation where we are not able to properly take care of the total demand in the plant, we would call in a contracting firm. In such instances we depend on our chief engineer to make these arrangements. This is not unusual at either the Fairless Works or other plants.

Member: Who makes the decision as to where you would send the forces, the general manager, or the superintendent of maintenance, or who?

Roy L. Leventry: Basically, it is my decision as to where the central shops men go in the event that several emergencies arise. This decision is, in extreme cases, of course dependent upon the effect to the entire plant and is mutually agreed upon by the general superintendent and the division superintendents.

John F. O'Hear: With reference to what Mr. Leventry is talking about on a recent big job we had on the open hearth, most any time we called central maintenance shops, the story was that the men were in the open hearth. But we said "We have a mill down and have to have men," and in pretty short order the men showed up. Where the men came from I do not know, but in two or three weeks' time the open hearths were rebuilt and the mills kept operating.

We have had a few major breakdowns; they were taken care of by central maintenance when we needed them, and the open hearth was rebuilt. The men showed up and we kept everything operating. I think our central maintenance did a good job on it. Sometimes it was pretty close; there were times we did not think anything would run for a few minutes or a few hours.

That does not answer the question as to who goes where, and who determines it, but I know that if we have trouble and need help, we get the help that we need.

W. C. Schulz: In the second floor offices, you have accountants. Are those accountants attached primarily to the shop? Are they part of the main plant accounting group? Are they actual cost accountants or do they just accumulate costs for the shop?

Roy L. Leventry: The accountants in the central maintenance shops offices are part of the main plant accounting group, but assigned permanently to our organization. The duties of this group are three-fold. One function is to accumulate and distribute all time and material spent by the various shops on work specified by shop orders sent in by the operating departments. Another function is to handle all the accounting activities in the central shops, beginning with the accumulation of all source information, developing, and preparing, as a final result, the monthly cost statements. The third function of this group is to analyze the cost statements of the central maintenance and utilities division, prepare variance explanations, trends, forecasts, and other tabulations or data required by the division.

C. E. Pritchard: Mention was made in this discussion covering facilities for steam cleaning of machinery and parts before bringing same into the diesel repair shop. Are similar provisions made in regard to preparing or cleaning machinery or equipment before it comes into the center repair shop?

Roy L. Leventry: We do have similar provisions for the cleaning of equipment in the machine shop. A degreaser 6 x 6 x 12 ft is located at the south end of the shop and is serviced by a jib crane located next to the tank. This can be seen at the lower right corner of Figure 6.

C. E. Pritchard: How about a piece of machinery that would be a little larger than that size which might be accommodated in the cleaning tank shown on Figure 6.

Roy L. Leventry: The cleaning of equipment too large for the tank provided is done by hand either outside or inside the shop. Solvents are generally used for the majority of the cleaning.

C. E. Pritchard: What facilities do you have for bearing repair, such as anti-friction, oil-film type, and so forth? Do you do anything in the way of recasting, such as babbitting?

Roy L. Leventry: We have two roll shops, one in the rolling division and the other in the sheet and tin division. Prior to doing any grinding on the larger mill rolls, such as work and back-up rolls, the bearings and chocks are removed. At this time the bearings are examined and cleaned. The oil-film back-up bearings are scraped or machined if necessary, and the roller bearings, used on work rolls, dismantled from the chocks and changed as required. All rolls are reassembled in these same shops, lubricated and returned to the respective mills.

The anti-friction bearings on other equipment are replaced as necessitated by wear.

We do not have, at the Fairless Works, facilities for the reconditioning of anti-friction bearings or the recasting and rebabbitting of oil-film bearings. In fact, we have a limited number of babbitted bearings. Practically all equipment was purchased with anti-friction type bearings. Outside of back-up roll bearings, the use of babbitted bearings is primarily limited to large motor-generator sets, turbogenerators and large main drive motors. The use of recirculating and filtered oil systems has kept wear on these bearings to a minimum.

C. J. Boyle: I would like to ask how crane maintenance is handled in the various mills and shops at Fairless plant. Is it handled by the mill and shop maintenance people, the central maintenance people or a combination of the two?

Roy L. Leventry: The maintenance of all overhead cranes is the responsibilty of the maintenance group, in whose area the cranes are situated. Thus, each operating maintenance group is responsible for the cranes servicing the operating units in his department. The central maintenance organization is in turn responsible for only the cranes in their department.

The crane repair shop, however, is available upon shop order request by any department, for work on any crane on the plant site. The actual maintenance is handled by the two groups. Generally, the monthly inspections and major repair jobs, such as wheel, gear, shaft and cable changes, are done by the central maintenance crane repair crew. The routine greasing, control maintenance, brake adjustment and other minor

repairs are done by the departmental maintenance groups.

This arrangement allows the shops planning group to properly schedule and coordinate the large jobs which frequently require the services of riggers and the machine shop.

F. L. Wise: Mr. Leventry showed a card that gave quite a bit of information on spare parts. Does that system cover all of your spares, how detailed is it, and if it covers those, I wondered what clerical force backs that up?

Charles W. Dunn: We decided that those pieces of equipment that were duplicated in the various divisions were excellent subjects for combining a plant-wide composite spares list. Unfortunately, the mechanical equipment is normally not duplicated from division-to-division with the exception of crane spares and therefore does not lend itself as readily to a composite listing such as Mr. Leventry exhibited on the electrical equipment.

The electrical equipment was studied for the entire plant and we prepared, with the equipment manufacturers' assistance, lists that showed the location and parts identity for each piece of electrical apparatus. The individual pieces were posted by area and totaled to an entire plant figure. We also listed the current price (for estimating purposes only), the number of spare parts recommended, and the number of parts on the initial order for stock.

The parts books were prepared by each manufacturer. The overall plant summary lists were primarily confined to electrical equipment. These tabulations were separated into a book for control equipment and a book for rotating equipment.

We also prepared a master motor book by area, horsepower rating, and voltage which provided a very good backcheck on the rotating equipment booklets. This master motor book was field-checked at the time that we prepared our master brush data compilation on the same basis as the equipment lists. We read the nameplate and inspected the brushes for all ordering data at this time.

Our principal reasons for exerting the effort necessary to gather and present the above data were:

1. Provide a storeroom minimum and maximum order point and establish the stocking requirements.
2. Eliminate the need for duplicate stocks in each area.
3. Provide a reference book for each division so that interchange of large parts could be easily effected.
4. Provide an initial spare parts listing on larger and more expensive items which would be carried in a central spares storage area.
5. Allow us to justify and effectively use the money allotted for the initial stores and spare inventories.
6. Make sure that the manufacturing area personnel had access to the same, ordering and listing of parts that we had so that their stocking would be adequate to cover any storeroom deficiencies. (This incidentally has proven to be a very major justification—the information available to the service and spares personnel in the district offices.)
7. Provide the service shops justification for copper and coil inventories and give them a back-check on coil winding information.

We have compiled crane parts lists, mechanical and electrical, throughout the plant, which are similar in nature and preparation to the lists previously described. Every bearing, oil seal, wheel, pillow blocks, shaftnig, etc., were listed on master prints and the storeroom stock was set-up based on the total number in use.

The lists described have been equally beneficial to the central shops, accounting dept., and operating dept. as well as any staff groups associated with these departments.

1956

AISE CONVENTION AND EXPOSITION

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A NEW INSULATION FOR AUXILIARY MILL MOTORS

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. . . . new insulations will give better and longer motor life . . . . because of the expanding range of temperature that such insulations will withstand, new test procedures are being developed in order to evaluate them properly . . . .

▲ THE rapid development of new insulating materials for electrical apparatus in recent years has presented the electrical designer with a formidable problem in the utilization of the optimum materials for a given service. Whole new families of synthetic materials, each with great numbers of variations, which are greatly superior to many of the natural materials in insulating properties are being developed. Not only have these materials presented problems of utilization and combination to designers, but they have also created problems of identification for purposes of ratings in accordance with accepted standards.

The presently accepted classifications of insulation are the well known Class A, B, and H definitions and acceptable operating temperatures for these materials have been established by various organizations. The greatest weakness in this setup is the definition of the materials which fall into these classifications. Essentially the definitions state that Class A consists of organic materials, Class B of inorganic materials with organic binders, and Class H of inorganic materials with silicones or equivalent as binders or of silicones or equivalent in resinous or rubbery forms. However with the advent of new synthetic "organic" materials, many of which are easily able to withstand the usual Class B temperatures, and considering that "silicones" cover a wide range of materials including "bouncing putty" and grease; it is obvious that the present definitions will not be able to stand the test of time much longer.

It is fitting that standards establishing organizations such as AIEE should move with due deliberation on such matters, and it is gratifying to realize that a new method of defining insulation materials is being considered. Whether or not it is eventually accepted as a standard of definition, the method being considered is one which can still be a valuable tool with which designers can test, compare, and utilize optimum insulating materials. In consists simply of testing complete insulation systems on "motorettes" or small cores which simulate a wound portion of a motor and under conditions which represent service. As a standard of definition, a complete system can then be defined as Class A, B, or H if it meets established minimum performances under specified test conditions. Much data is currently being collected to establish the test conditions and performance criteria which will define the classifications.

As a designers tool for utilizing materials, it is advantageous to be able to test many materials and combinations on these motorettes, subjecting them to conditions equivalent to accelerated life tests on actual motors but without the expense of the actual motors. We would like to describe in some detail just how this method of selection was used during the recent development of a Class H insulation system for our line of AISE standard auxiliary mill motors. The equipment used and conditions to which the samples were subjected were similar in principle to those which are being studied by AIEE as possible standards of definition.

Obviously, if one is to establish test conditions simulating service, one must determine what the service conditions are that cause failure and what characteristics are desired in the material to make them withstand these conditions. On relatively low voltage rotating machines subjected to severe mechanical duty in high ambient temperatures such as the auxiliary mill motor, the major cause of insulation failure is mechanical breakdown after heat ageing. In other words, the materials lose their mechanical properties as a result of temperature and time. They then undergo shrinkage, loss of bonding strength, loss of film continuity, etc., which permits slight relative movement between wires or between coils and cores. The result is chafing and abrasion to the point of actual cutthrough and failure. Actually the strictly electrical characteristics such as dielectric strength, dielectric constant, and power factor are of relatively little importance for this kind of apparatus. The dielectric strength of any of the presently available insulations is enough to permit reduced insulation thicknesses if we could be sure of uniformity in the first place and keep it in place and intact after heat ageing and vibration. The tests, then, to which the sample insulations were subjected consisted of re-

peated cyclic periods of high temperature to destroy properties, vibration and high humidity to produce damage if the properties had been destroyed, and electrical tests to determine if the equivalent of a service failure had resulted.

In order to test many complete insulation systems without involving expensive mechanical parts such as bearings, shafts, and bells, frames, etc., small motorette cores were wound with insulated coils. Figure 1 illustrates the motorettes which were used to test armature coil insulations. It consists of a short stack of rectangular laminations with 15 slots into which insulated coil sections were inserted. By using laminations instead of machined slots in solid iron, a slot roughness comparable to an actual armature core is obtained and the insulation is tested for its resistance to damage from this roughness. The coils were held in the core by a top plate which had bosses on the core side simulating the intermittent pressure areas of core bands. Two coil sections were placed in each slot simulating the top and bottom sides of an actual winding. Each coil side contained a number of insulated conductors, taped or wrapped with ground insulation, and had received the complete manufacturing process being contemplated for the insulation being tested. In addition any top and bottom spacers, slot liners, or other auxiliary insulation pieces were applied and the final wound motorette was given the desired treatment process of a complete armature. By winding each slot of a given armature motorette with a different insulation system, each system is subjected to exactly the same subsequent conditions and comparisons can be made without concern over slight uncontrollable variations in conditions. Several such motorettes were used in order to make comparisons under different conditions and to obtain a degree of statistical data.

Figure 2 illustrates the motorettes which were used to test field coil insulations. Blocks simulating a pole piece were fabricated to a stiff plate simulating a motor frame. The coils were clamped in place on the pole by a relatively thin plate to give a degree of spring action followup of any insulation shrinkage comparable to our standard method of coil assembly. In order to test all components of field insulation, the motorette coils were wound to simulate compound coils with typical conductor sizes for both the shunt and series portions. The motorettes should be wound with parallel wires in hand so that test voltages can be applied across them to check for failure of turn insulation. The final coils, of course, contained all the elements of a final insulation system including conductor insulation, phase insulation between the shunt and series portions, ground insulation, outer protective tape, and complete impregnation and treating processes. The field coil motorettes were much bulkier per insulation system, and in order to return ease of handling they were prepared as individual units.

In this manner, armature and field motorettes were provided which contained the complete insulation systems of actual motor coils. Many samples could be prepared at low cost, and they could be subjected to varying and controllable conditions of heat, vibration, and electrical stress without the much greater cost of producing an equivalent number of sample motors.

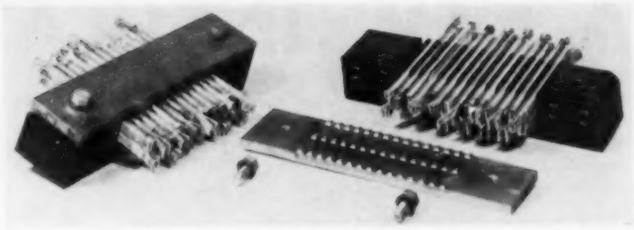

Figure 1 — The use of small "motorette" cores for testing saves both time and money.

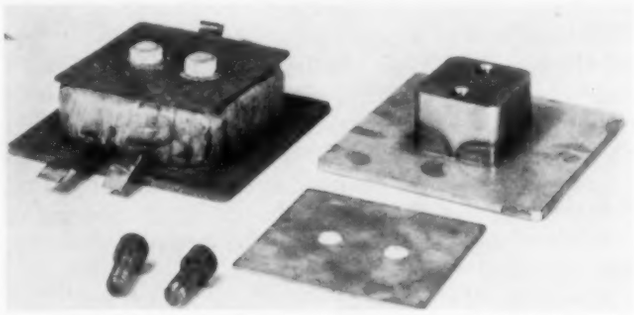

Figure 2 — Field coil insulations are also tested with "motorettes."

Furthermore by the elimination of other parts, the insulations could be subjected to extremes of temperature and vibration which produce accelerated deterioration and evaluation without the interference of possible failures of other motor components.

Insulation deterioration is generally a function of both temperature and time so that elevated temperatures can be used to shorten the evaluation time. However it was believed that if the temperature were raised to values which greatly shorten the life of good Class H materials, it would be possible that abnormal phenomena might occur which would give false comparisons of the relative performance of materials at rated temperatures. In other words the time-temperature characteristics may not be alike for all systems, or some systems may have critical temperatures above which degredation rates suddenly become much more rapid. For these reasons different samples of each insulation system were subjected to different temperatures during the heat ageing portions of the test cycles. Temperatures used were 200 C, only 20 C above the accepted hot spot temperature for Class H insulation; 250 C; and 300 C at which temperature the exposed copper terminals oxidized rapidly. In the beginning, the heat ageing portion of each test cycle was only one day, but this was increased for each subsequent cycle so that after five cycles the heat ageing time was five days and stayed at this value for the rest of the tests.

At the end of each ageing period, the motorettes were immediately mounted on a vibration table and vibrated while still hot at 0.015 in. at 60 cycles per second. This is much greater vibration and acceleration than can be expected in service except, perhaps, for occasional single peak shocks, and was continued for six hours in each test cycle. Again, the objective was to produce extreme conditions which would accelerate deterioration.

Following the vibration period, the motorettes were placed in a sweat box and held in a 100-C, 100 per cent

humidity atmosphere for 24 hours. During this time the moisture would penetrate any flaws that might have developed in the insulation due to heat and vibration, would be soaked up by any excessively hydroscopic materials, and would contribute to failure on subsequent electrical tests.

Finally after having been subjected to the degrading influences of heat, vibration, and high humidity, the coils were electrically tested to see if failure had occurred. Since we were interested in detecting only the equivalent of service failure, voltages were applied which were only slightly in excess of normal. This line of motors is designed to operate up to 600 volts; therefore the coils were tested at 1000 volts to ground and between windings, while the voltage applied between turns or individual conductors was limited to 200 volts. These test voltages were applied while the coils were still wet from the sweat box and in most instances the leakage currents were quite high. Insulation resistances measured with a "megger" were very low and current limited hipot apparatus with high internal impedances often indicated failure. Therefore low impedance hipot apparatus which would hold the applied test voltage in spite of high leakage current was used. The insulation was not considered to have failed unless a failure occurred which would have put a motor out of service.

These motorette testing cycles were continued for 22 weeks by which time several of the insulations had failed and many of the coils had become loose in their cores. A few of the insulation systems were still standing up well and showing no external signs of degredation. The tests were brought to an end by hipotting the remaining coils to failure and disecting them to compare their relative condition. Final selection of the insulations to be used from among those which survived was based on these examinations and comparisons of handling ease, costs, simplified processes, etc.

The results of the laboratory motorette tests were very convincing, but the amount of experience with this method of insulation selection is still limited. Therefore, it was felt that life tests in actual motors should be conducted before the new materials were put into production. This was done running two small motors, one with the new insulation and one with the previous Class B insulation, on identical cyclic overload tests at elevated temperatures, outdoors unprotected, and subjected to abnormal vibration. These life tests have confirmed that the new insulation is superior. We have every reason to believe that motorette test procedures similar to those used in this development can not only become a very valuable tool for the selection of insulating materials; but also, after proper standardization of procedures and values, can become a much improved method of establishing the temperature classification of any given insulation system.

AISE

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By J. SERENKA
Master Mechanic
Strip and Sheet Division
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MAINTENANCE VIEWPOINTS

. . . . maintenance ideas vary widely . . . . the objectives however must be the accomplishment of a good maintenance job, minimum downtime, and economy of material and labor.

FROM MANAGEMENT'S VIEWPOINT

▲ IN discussing maintenance or maintenance programs, we must accept the fact that each company regardless of size or type of product, has definite ideas regarding maintenance and its relative importance on the overall production.

The most important questions in the minds of most maintenance people are: "what program and whose program." If the master mechanic is to prepare any kind of program, he must first determine the administrative thinking in his plant on capital expenditures; for machine tools, expenditures for improvements, including buildings, etc., and the person to whom he should turn for this information is his supervisor, usually the superintendent and eventually, the works manager.

For example, let us consider for a moment one segment of the maintenance department's work, the production equipment. Naturally, the superintendent and plant manager want uninterrupted service from the equipment. But, equipment, like human beings, eventually wears out.

If he is doing a really intelligent job, the master mechanic has compiled a record of maintenance costs for each piece of equipment. He knows its current book value. How much should he spend for major overhaul or repairs?

Progressive companies like ours prepare a long range equipment replacement and improvement program. In preparing this program, we have considered the opinions of operating supervision, and have taken advantage of the maintenance department records. In addition, we will discuss the entire program with the design engineering department, and consider their recommendations.

With all the necessary information in his hands, the master mechanic will discuss the larger expenditures with his supervisors and decide on major overhauls or repairs. From his own records and experience, he knows the age, condition, and productivity requirements of the equipment. From the replacement program, he knows the approximate replacement date of each. He must make his own decisions based upon these factors. If a major expenditure will prolong the life of a piece of equipment well past the replacement date, the master mechanic would only advise the operating personnel and superintendent of that fact, so that he in turn can discuss the expenditure with the plant manager and proceed with the necessary adjustments to budgets. To me, this is a simple lesson in the economics we all apply in our personal lives. Would a man replace or completely overhaul the engine in his car if he expected to trade it in on another car in six months? On the other hand, would he attempt to operate the car without spending anything on maintenance if he knew he could not trade it in for two years?

We realize of course that you cannot anticipate every major breakdown, but if proper records are kept, the master mechanic and the men under him can fairly well determine the life expectancy of the equipment. At the strip mill, we are made very conscious of equipment condition through an accurate record of the date and findings of each preventive maintenance inspection and the recommendations of the maintenance men who made it.

Incidentally, we consider the preventive maintenance program one of the most important programs on the agenda of the maintenance department. We are also very conscious of the proper use of equipment and always object if it is operated beyond its capacity.

Another major item in the budget of any maintenance department is the upkeep on buildings; such as replacing bad sheeting, painting of buildings both internal and external. At today's costs, this is a very large item of expense, and unless the job is properly planned, it can wreck the maintenance budget.

If our administrative officers take even a normal amount of pride in appearance of our buildings, and are conscious of the large sum of money to be saved by preventive maintenance painting, one will have established a long range painting program. We are at the present time working on a painting program which involves thousands of dollars. We have completed some buildings and expect to continue the program and keep all buildings in excellent condition.

Qualifications Needed—After the administration has provided the tools and will permit you to do the job, management is entitled to specify the return it expects

for its investment. In order to give management what it expects, certain qualifications are needed. The head of the maintenance department should have these three capabilities:

1. Ability to use common "horse" sense.
2. Ability to organize a department, select the proper supervisory personnel, then permit them to function as real supervisors.
3. Ability to analyze all maintenance functions and plan in advance to handle the problems in a safe, efficient, and orderly manner.

It is a basic fact that the maintenance department is directly a major contributor to the profits of its company through their knowledge and control of many expense items that affect the profit and loss statement. Anyone can be successful, if given unlimited capital for replacement and repair parts, inventories, and manpower. A good maintenance supervisor watches his own departmental budget as closely as the controller or auditor, and should take pride in operating on a minimum budget.

The master mechanic who is doing a good job has organized his maintenance department in such a way that all details and general problems requiring immediate attention are handled by his general foreman or assistants. This leaves his time available for the most valuable functions, such as:

1. Consultation and consideration of major problems.
2. Advance planning.

Advance Planning—Advance planning is a very important function of the master mechanic. I presume, of course, that he is advised of all expansion or improvement plans under consideration. In our company, the master mechanic handles every detail of any type of new construction or remodeling and assists in originating the original plant estimate request presented to the board of directors for appropriation purposes.

By permitting the general foremen to operate their respective departments, the master mechanic has been able to devote much of his time to budget analysis and investigation of methods and procedures, and by cooperation from all departments, has been able to reduce our maintenance cost to a very low figure.

As a result, we have today at Jones & Laughlin strip mill, all of the following maintenance benefits:

1. High equipment productivity.
2. Very accurate and tightly controlled budgets.
3. An established long-range program covering every phase of maintenance.
4. Minimum replacement parts (spares) inventories.
5. A department which can operate during a prolonged absence of top supervision.
6. Safe, clean and orderly surroundings.

We are constantly striving to enforce our program. We have talked about what management wants from the maintenance program; now management must know how to get what it wants. The answer to this problem lies in getting the right people for the job.

The men on the maintenance team must have the personal characteristics, mental attitudes, and spirit needed to get results. A maintenance team that lacks trouble-shooting ability is severely handicapped. Here is a tried and tested plan for developing a good maintenance team. First, set down the things you want your maintenance program to accomplish. Then, along side of each one, write down the characteristics needed to do it.

One of the things we want to accomplish is uninterrupted operation of production equipment. We will make this Item No. 1.

No. 1. This requires foresight, planning ability, and ability to take action. Foresight alone is not enough. You have heard people exclaim, "I just know something dreadful is going to happen" and then just stand and wring their hands. Anyone knows that parts are going to wear out. Someone in the maintenance team must determine what parts are most likely to wear out and when, check wear from time to time to prevent failure, or be ready with replacements if the breakdown happens before it can be prevented.

No. 2. Equipment must be kept in a condition to hold quality standards—skill, ingenuity and knowhow are needed for this job. Such things as alinement, leveling, and take-up to compensate for wear come into the picture.

No. 3. Safety and good housekeeping—It seems that the basic characteristic needed to maintain safety is human interest or regard for the other fellow. For example: the whistle blows for lunch. A piece of angle iron, wire, or some other object is lying in an aisleway where everyone going to the canteen must step over it. The first couple of men jump over the obstacle and hurry to get places near the head of the line. The third man is also in a hurry, but he sees the object, adjusts his stride to jump over it, changes his mind, stops, picks up the dangerous obstacle, puts it in a scrap box where it belongs, and then hurries on to the canteen. He lost his place, and perhaps 15 or 20 men get ahead of him. In the split second when he changed his mind, he knew that stopping would cost him some time, but his basic interest in safety of other people forced him to stop and remove the danger. Regard for the other fellow is a must if you are to spot dangerous conditions and remove them.

No. 4. Low cost production from plant in relation to dollar outlay and shutdown cost—Ambition seems to be one of the most important characteristics needed here. Ambition to be a leader that will compel you to keep up to date with the best. Keep looking for ideas, new or old, that will help you. Do not be afraid to use an old idea if it is a good one, and many of the old ideas are good.

No. 5 Accurate budgeting of maintenance costs—Here, self-discipline and drive seem to be of great importance. Undoubtedly there are many people who know perfectly well how to keep a budget, but have never actually done it. It takes something more than just knowhow.

No. 6. Accurate planning and scheduling of maintenance operations—Organizing ability is needed here, but there is something more. Plans and schedules seldom come out right the first time, even though they are apparently well organized at the start. But trying again, improving here and there, will get better results. Trying again and again requires determination.

No. 7. Minimum inventory of spare parts, equipment, and supplies—This of course, takes some foresight that is required to maintain uninterrupted operation. Good judgment is essential also, since the cost of

spare parts must be weighed against the risk of getting caught without them.

No. 8. A minimum of paperwork—To achieve this, the maintenance man must have directness and a broad viewpoint. One important thing about paper work is to know when you are finished. Anyone who has done any teaching realized that personality traits are almost always revealed in the answers to a written examination. Some students write 100-word essays when the question requires only a one sentence answer. They know the answer alright, but they just do not know when or how to stop writing. The man who leans toward too much paper work is likely to write a great many letters. This means he spends too much time in the office and too little time out in the plant. A maintenance supervisor who spends plenty of time in the plant is not likely to be a red tape man.

No. 9. Low cost maintenance with the right amount of mechanization—This maintenance problem ties right in with No. 4 (low cost production from plant in relation to dollar outlay and shutdown cost). It requires ambition to keep abreast of the best ideas, and judgment to keep from going overboard. Beware of the day dreamers who are fascinated by an expensive piece of equipment and use it only once or twice a year. The maintenance team should judge equipment in the light of whether or not it will pay for itself. This takes a sense of responsibility and a desire to be a good manager who would be proud to render an account of his operations at any time.

No. 10. Working conditions that will make for good worker morale—Here again, it is necessary to like people. A certain percentage of the complaints about working conditions are just plain gripes. But, if you like people, you reserve judgment on a complaint until you get all the facts. A person who consistently labels all complaints "gripes" without first checking the facts lacks a basic characteristic necessary to the man responsible for maintaining good working conditions. Even when employee's complaints are not well founded, it takes genuine human interest, understanding, and patience to prevent a gripe from becoming a smouldering resentment that could build up to bigger trouble later on.

The attitude of the maintenance team can be transferred to other employees. If it is of genuine interest and helpfulness, it will contribute greatly to better worker morale throughout the plant.

Let us suppose a maintenance man is checking a complaint and his first remark is, "Well, what's eating you guys now?" or as a contrast, suppose his opening line is, "What can I do for you?" If you were the worker, which remark would be better for your morale?

No. 11. Ability to handle workers—Fairness is almost universally accepted as the primary ingredient in the formula for handling workers. We constantly find ourselves trying to solve the discipline problem by thinking in terms of the offender. Perhaps we would be more likely to develop a superior working force if we thought also in terms of the larger group that did not break the rule. Some supervisors are lax in enforcing rules because they do not want to incur the ill will of the offenders. However, if they do not enforce the rules, they will incur the ill will of the rest of the men, the majority of whom have no intention of ever breaking a rule and trying to get away with it. The larger group, in all fairness, is certainly entitled to consideration. Furthermore, it is your true working force, the group that decides whether or not you know how to handle workers.

No. 12. Accurate and complete reports of maintenance operations and costs as soon as the work is completed—It is a common human failing to be eager to give prompt, accurate reports when one is sure they will be favorable, and not so eager when one is not so sure. What characteristics motivate a man to give prompt, accurate reports all the time? Honesty is required, of course, but it is more than honesty that returns lost articles. It is the honesty to make an accurate report even when no one else knows whether or not it is accurate.

Looking back now on the twelve points we have covered, we find the following characteristics have been mentioned: foresight, planning ability, action, skill, ingenuity, knowhow, human interest or regard for the other fellow, ambition, self-discipline, drive, determination, good judgment, directness, sense of responsibility, patience, fairness, and honesty with oneself.

You might say that if the maintenance people had all the personal characteristics and mental attitudes enumerated, we would get all management could possibly want from the maintenance program. This is not so. Our maintenance team might be no more effective than a locker room full of football stars who had never played together. What we need also, is to have all the talent welded together as a smooth working team.

What management really wants is for the maintenance team to sit down and compare its abilities and attitudes with those that are required, put to good use what it has, and determine to develop those it does not have.

By thus working together, setting up their goals and helping each other to reach them, the maintenance people will be welded into a smoother working team and the maintenance program will be taken in stride.

FROM MAINTENANCE DEPARTMENT'S VIEWPOINT

We are discussing two groups of people, maintenance people and management people, and more specifically, the wants of one that may be supplied by the other.

The fact that wants or desires are indicated is a good healthy sign. When wants are evident, we know we are associated with people who are interested in improvement, and the progress of civilization over the years has occurred because the wants of people furnished incentive, to themselves or to others, to improve living standards.

To forestall any misunderstanding, let us first establish that the wants to be described are not felt in the same degree by all maintenance people. Many do not want any change in their present status, and are doing an excellent job. Also, we do not presume to speak for any individual or group of individuals, though it is my firm belief that wants may be highly individual, including many of the wants of maintenance.

The wants to be discussed here are those that, from

talks with other maintenance people, published articles, and situations that have been worked out or are developing in our own plant, we judge, are fairly common.

The first and most important want felt by maintenance people is *the desire to be on the team*. Because of this desire, we have a maintenance department today, but in addition to that desire, we must have training and skill if we are to satisfy it. We are a progressive part of the team of competitive American industry.

You have heard this desire called by various names. Phrases often used are: "rank within the organization equal to that of production," "authority consistent with responsibility." These phrases and others like them however, imply that this want can be fulfilled by executive order. This is not so. What we want is something more than what a cold written order or an organization chart can bring about.

The most successful teams we know are those on which each member performs his assignments with the confidence and support of his associates, on which all members work as one for a common result, and the achievement of the goal further cements the team relations, and makes possible even greater achievements.

Those who made the greatest strides toward improved maintenance operations were established as members of industrial teams. Being on the team incites a natural desire to compare the alleged advantages of the newer techniques with those of past and present ways of doing things. It means that we have acquired the incentive to be a winning team, and that everyone is willing to help improve practices whenever the need for improvement is evident. It is when we as maintenance people, under management's leadership and encouragement, stand shoulder to shoulder with sales, finance, procurement, personnel and production for the purpose of supplying a market with a product or service under competitive conditions that the greatest improvements in maintenance are made.

These new improved techniques create other wants that deserve mention here, though they are secondary to the primary desire to be on the team. If the new techniques are introduced before the primary desire is satisfied, their purpose may be misconstrued; it may be considered that we have adopted them with a view to personal advancement. Only after team work has been established can they achieve their full effectiveness.

The second most important of the maintenance department's wants is the *desire to do a good maintenance job*. Just as the sales department requires and gets a well-engineered product for successful sales and the production department needs and gets an ingeniously engineered process for maximum economical production, maintenance people want good maintenance engineering applied to their operations or the opportunity to develop good maintenance engineering, and we have that opportunity at Jones & Laughlin strip mill. This is greatly encouraged by our works simplification program.

Under this heading would fall such things as a planning and scheduling system, preventive maintenance, progressive equipment replacement program, planned lubrication and corrosion control and many other functions that are peculiar to the strip mill. It is not necessary to elaborate on the details of the system. The point is that it is important that management encourage maintenance engineering to adapt the right sort of programs, that it provide enough funds to make possible their development and installation, and see them through the try-out period.

Our next consideration should be material. Maintenance people want to have the proper material available at the right time, and here again, the same desire is felt by other departments of our organization. We all know that production cannot get the proper results if it is not supplied with right materials, that the sales department must have the right materials which the customer wants when they want them or sales will be lost.

Good maintenance stores and storekeeping will supply this need. Maintenance people want from management the opportunity to establish this type of maintenance operation. Recently in the strip mill, we have allocated more room, and are spending more money to give the maintenance people a better place to keep the spares and improve the spares program.

Capable fellow workers—After we are given engineering programs that provide thorough knowledge of the work to be accomplished and maintenance stores that can supply the proper materials, our next consideration is our associates, the workers in maintenance. Maintenance people want to work side by side with fellow workmen who are craftsmen and good team workers, men who can handle their projects successfully. We want management to provide good fellow workers, either through a progressive selection policy or through training programs and apprenticeships. In most cases, both methods are used throughout the strip mill in order to obtain a well balanced group of maintenance workers who are equal to the technological progress of American industry.

The maintenance people who meet these standards want shops equipped with tools that allow them to perform their assignments in a modern efficient manner, and they want good personal facilities as well. At almost every construction meeting, we are advised by our superintendent to take advantage of the new modern tools. He constantly encourages us to develop new ways of doing things.

Knowledge of results—Lastly, maintenance people want accounting procedures and statistics that will provide them with full knowledge of the results of their operations and comparisons with past experience. We want accurate information designed for maintenance use to justify every operation and prove or disprove the value of every innovation. When the maintenance department has information of this kind, they can see the operational weak points that must be strengthened and judge which operation should be further improved. This way, almost all decisions are removed from the realm of personal opinion and placed under the jurisdiction of actual results.

Aside from the above, management should encourage membership in various engineering and technical societies. They should provide expenses to the technical and scientific meetings and conventions or shows sponsored by the engineering societies. Management should provide the opportunity to visit various plants.

By R. L. DEILY, Steel Mill Representative, Air Reduction Sales Co., New York, N. Y.

Welding and Cutting

▲ IT has been estimated that direct operating labor makes up over 80 per cent of the average maintenance welding job in the steel mills. Therefore, the most appreciable reduction in maintenance welding costs can be obtained by mechanization of welding operations wherever possible. A detail job-by-job description of welding and cutting in maintenance would be both tedious and difficult. However, there are certain underlying similarities between all maintenance welding work, which will be outlined in this paper. These similarities can be summarized to form a method of approaching maintenance which should be helpful in making such work less costly to the mills.

Maintenance work is inherently a high labor activity, both because of the nature of the work and because so many maintenance jobs are done under breakdown conditions. At such times, the prime problem is to get equipment back into production, regardless of costs. Here, not much can be done in the way of labor-saving, except in so far as the preventive maintenance programs so well understood by the mills are successful. It is with routine maintenance and equipment replacement problems that this paper will deal.

THE NEED FOR MECHANIZATION IN MECHANICAL MAINTENANCE

General steel mill figures indicate that in the 25-year period from 1929 to 1954, maintenance costs per ton of product shipped increased five times. From 1937 to 1955, maintenance costs in a typical steel mill increased from about $7 per ingot ton produced to about $14.00. These figures include both rebuild and mechanical maintenance costs. It is significant that the rebuild costs, involving primarily brickwork, increased less than 50 per cent in those years from 1937 to 1955, while the cost of mechanical maintenance increased 200 per cent. It is a matter of fact that a great deal of mechanization of rebuild maintenance has been achieved, through the use of payloaders, palletizing, conveyors, and so on. It is therefore a fair conclusion that the relatively small increase of 50 per cent in these rebuild costs has resulted from the use of such mechanization methods.

This presents a clear challenge to the mechanical maintenance organization to keep down that 200 per cent increase. In order to do so, maintenance must also mechanize, so as to keep its cost in line. Obviously, this is more easily said than done. Also a great deal of mechanization has been done by mechanical maintenance departments. However, the process of mechanization is a continuing one, as labor costs go higher and new methods are introduced.

There is another important factor which makes mechanization of mechanical maintenance even more pressing in the coming years. Steel industry leaders are in almost unanimous agreement that steel capacity must be increased in significant amounts in the next decade. Along with this increase in capacity will be strong pressure on operating personnel to reduce costs in order to increase profitability of operations. Since one of the major controlling items of costs in the steel industry is labor, we can expect that the use of labor saving equipment will increase. We all know that this is not new (or even unique to the steel industry), since one of the determining factors in any capital improvement in the steel mills has been the amount of labor it will save. What is not so commonly realized is that the continuous introduction of labor-saving equipment in the steel industry has the effect of making maintenance problems continuously more difficult. In many ways, we are getting more production per manhour at the expense of higher maintenance costs per ton. So, the mechanical maintenance organization must keep pace with labor-saving methods in its own field.

Now, where do welding and cutting fit into this maintenance picture. Table I shows typical welding and gas cutting operations in a steel mill, from a process standpoint. It can readily be seen that there are a great many available processes for the mechanical maintenance man, and it is probably true that most of them will be used in any large mill over a period of time. However, only some of these processes, particularly oxygen cutting and electric welding are sufficiently used to lend themselves to any degree of mechanization for maintenance.

TABLE I

Typical Welding and Gas Cutting Processes Used in Steel Mills

- A. Welding Processes
  - 1. Oxy-acetylene welding
    - A. Fusion welding
    - B. Braze welding
  - 2. Thermit welding
  - 3. Arc welding
    - A. Carbon arc
    - B. Bare metal arc
    - C. Shielded metal arc
    - D. Submerged arc
    - E. Gas shielded metal arc
      - (1) Non-consumable electrode
      - (2) Consumable electrode
  - 4. Resistance welding
- B. Oxygen Lancing Process
- C. Oxygen Cutting Processes
  - 1. Oxygen cutting
    - A. Manual
    - B. Machine
  - 2. Oxygen machining
    - A. Scarfing
    - B. Gouging
    - C. Edge preparation
- D. Gas Shielded Arc Cutting

Application of mechanisms to production welding is now the accepted practice . . . . many of the principles can be equally well applied to non-repetitive jobs such as the maintenance man must do.

in Steel Mill Maintenance

SIX ESSENTIAL FACTORS IN MECHANIZED CUTTING AND WELDING

Flexibility in use has been the outstanding characteristic of both oxygen cutting and electric welding since their early days. Oxygen cutting and hand welding could readily be done by putting a man on one end of a torch and the job on the other. Fortunately for maintenance this is still true, and this simplicity of application accounts for the fact that practically every maintenance crew includes a burner and a welder.

The integration of cutting and welding processes with machines proceeded at a fairly slow pace prior to World War II. It took the urgent demands of World War II to bring about the maturing of cutting and welding machines to standard production work. In recent years, the application of newly developed controls and design principles have placed cutting and welding applications in the machine tool class, with certain peculiar advantages inherent to the processes.

These advantages stem from the inherent flexibility in cutting and welding, as well as the fact that these processes require no physical contact with the work. Thus, designers of cutting and welding machine tools can make them light, aiding in retaining flexibility in the design of special purpose machine tools. Before describing some of the various types of mechanized cutting and welding machines, it is instructive to examine their basic characteristics.

The essential factors in any mechanized cutting and welding process are:

1. A materials handling system.
2. A machine mechanically designed for the job.
3. An operators station with complete electrical controls.
4. A gas or power system engineered for adequate supply.
5. A known process.
6. Trained personnel.

Which of these six essential factors will be designed into a single machine depends on the job to be done. Inevitably, the more they are completely engineered into a single set-up, the more the flexibility of the cutting and welding process is lost in the interest of higher production and lower costs.

This caution is particularly important for maintenance people, who very seldom have high production work. However, even in maintenance work, there are types of cutting and welding where there is enough similarity between jobs to use the principles outlined above for guiding a cost-cutting study.

We will now take a look at some applications in the separate fields of oxygen cutting and welding. These applications are by no means exhaustive, and are presented only as examples for further study of mechanizing cutting and welding operations.

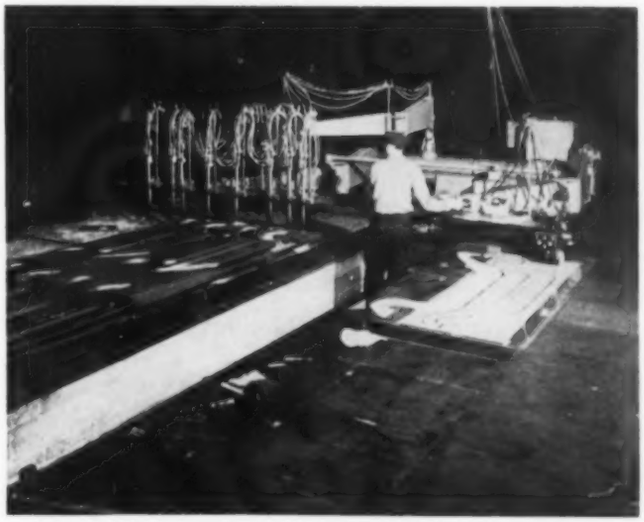
OXYGEN CUTTING MACHINES

Practically all steel mill maintenance work involves a great deal of precision cutting for steel fabrication. Here, the modern pantograph machine shown on Figure 1 has relatively high flexibility with extreme accuracy of cutting results. Current design of such units includes gas systems with solenoid-controlled valves, electrically-operated torches, and the electronic eye tracing device, all being controlled from a single station.

With all control elements electrically operated, it is now possible for the operator to work from a single station on a push-button basis. The nerve-wracking business of manually following a template, all the time being concerned about turning on and off the oxygen for cutting, is now done electrically for the operator. As a result, he can concentrate his attention on the over-all progress of the job. He, therefore, does better and more precise work.

The direct application of such oxygen cutting machines to maintenance shops will depend on the shop conditions. Of particular importance to maintenance

Figure 1 — Current precision oxygen cutting machines have single station controls for push-button operation.



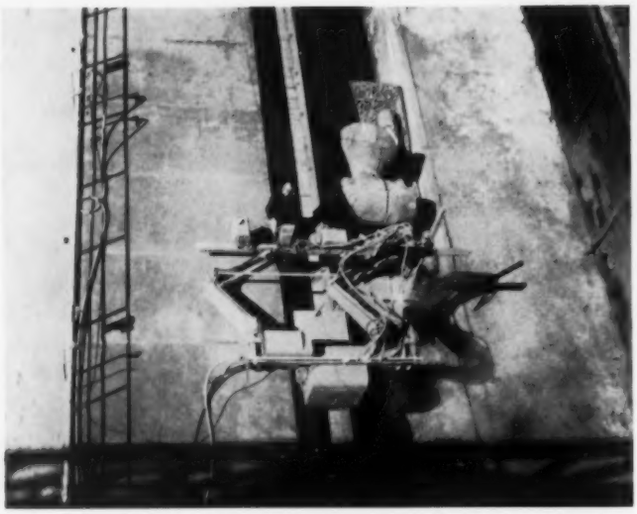


Figure 2 — Material handling on rail cars along with complete electrical controls make heavy scrap cutting a one-man operation.

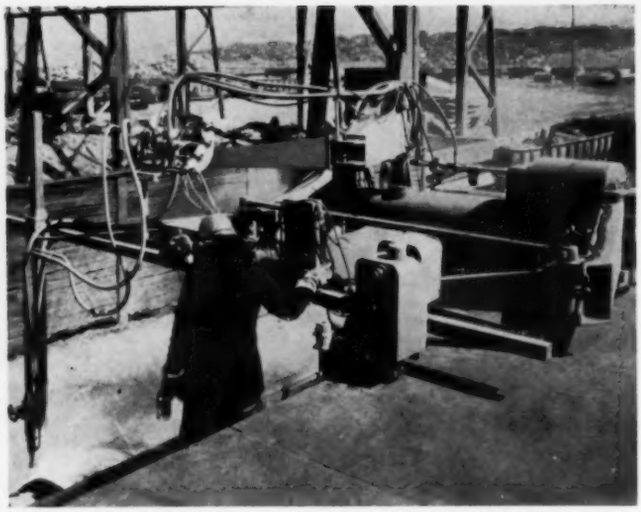


Figure 3 — Close-up shows operator's station of the installation shown in Figure 2.

work is the rapid preparation of templates that is made possible by the fact that the electronic tracer works from lines on a suitable template material. For those interested in the details of the operation there is a very excellent description by Mr. H. B. Cary (the Welding Journal, October 1953, page 957) of great savings in steel and manhours through the use of these cutting machines.

Such completely integrated oxygen cutting machines will be best suited to centralized maintenance shops. However, even isolated maintenance operations will be able to use less specialized cutting machines. Under these conditions, too, consideration of the set-up with the six factors in mind could readily bring out improvements in the operation for lower costs.

HEAVY CUTTING

Since the maintenance department is frequently called upon to make heavy or difficult cuts, the following description of scrap cutting should be of interest. Present day oxygen cutting of heavy scrap is a vital factor in maintaining hot metal production schedules and reducing costs. Such heavy cutting required the development of successful processes, after which the operation could be mechanized. These successful processes include (1) the development of oxygen cutting torches to be able to cut, on a routine basis, steel thickness up to six ft, or more, and (2) the use of iron powder where needed.

Because of these recent developments, oxygen cutting of scrap on substantially a one-man basis is now a routine operation. Figure 2 shows this operation. All six essential factors for mechanization are illustrated by this job:

1. Materials handling by rail car to and from the machine.
2. Machine designed for the job.
3. Operator's station shown in Figure 3.
4. A complete gas system, including capacities of up to 7000 cfhr of oxygen.
5. A known cutting process, which, as previously stated, had to be developed before mechanization was possible.
6. Trained personnel, fully aware of cutting process requirements and safe practices.

It is hoped that these selected examples of the mechanization of oxygen cutting will suffice to suggest how the six basic factors are used in specific jobs. We will now review some examples in the electric welding field.

MECHANIZATION OF ELECTRIC WELDING PROCESSES

It is probable that the wide-spread mechanization of electric welding processes is still in its infancy. This statement seems true even though such processes as submerged arc welding of cylindrical objects is routine, along with the use of such material handling methods as positioners and roll-turners. Mechanization of the newer inert gas shielded welding processes is just beginning to be common, while the long-sought dream of contour welding is still in the development stages. In addition, the ease of application of stick electrodes makes it likely that they will be used for a long time to come.

However, the six factors that are inherent in any mechanized set-up still apply, and any welding job should be considered with these in mind.

For instance, the recent rapid increase in the use of iron powder coated electrodes illustrates a change in the simple stick electrode process which is having important labor-saving effects. The following discussion of these new electrodes illustrates the effect of a change in Factor 5, the process, in saving labor.

Figure 4 shows the pounds of weld deposit and the welding times for depositing 50 pounds of two iron powder electrodes, and illustrates the greatly increased welding speed of the E 6024 electrodes. When translated into feet of ¼-in. fillet from each 50-lb box, as shown on Figure 5 we see that the E 6012 electrodes do somewhat better than the E 6024. However, in the all-important labor-saving yardstick of comparative feet of fillet per welder-hour, Figure 6 shows an increase of 100 per cent for the iron powder electrodes. Obviously, these electrodes will be used wherever they are applicable, with important savings in cost to the maintenance department and the steel mills.

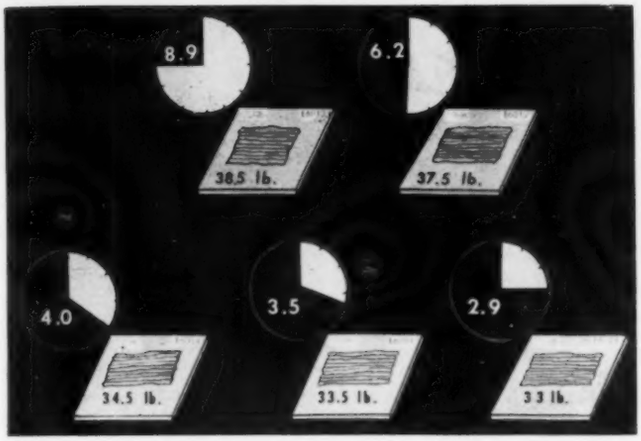


Figure 4 — A 100 per cent increase in welding speed results from changing to iron-powder electrodes. Data gives number of hours to weld 50 lb of electrodes, and lb of deposited metal resulting.

MECHANIZATION OF GAS SHIELDED WELDING PROCESSES

Since the gas shielded welding processes, and particularly the gas-shield type of consumable electrode welding, have been commercially available for only a relatively few years, their uses in mechanized maintenance welding can only be suggested.

Welding of bronze guides by this method is one of the earliest applications, and becomes more general all the time. Similar applications to aluminum pistons and to various cast copper items in the steel mills, such as electrode holders and tuyeres, is saving steel mills many thousands of dollars per year. Inert gas welding of materials such as copper, bronze, aluminum and stainless steels were first developed and now make these hard-to-weld metals easily weldable on a routine basis.

On the other hand, the application of this method of welding on steel in the early days of the process remained both difficult and somewhat costly. In recent years, the development of special steel wires, gas mixtures, and, finally, the use of CO_2 as a shielding gas, have put this kind of welding of steel on a sound production basis. It is of interest to the theme of this paper, that the use of CO_2 for gas shielded electric welding is best done in machine welding.

Because of the difficulties of applying any mechanized welding process to maintenance work, it should be noted that this method of steel welding is now being applied primarily to production welding, which will familiarize welding people with its use. A typical production set-up for welding of mild steel is illustrated in Figure 7. This job involves welding both the longitudinal and transverse seam of cylinders mounted in jigs. Again, all the elements of mechanized welding such as single station control, materials handling and so on are illustrated by this job.

There are considerable savings resulting from such gas shielded electric welding of steel, including high welding speeds and the important advantage that no slag cleaning is necessary. We can expect that installations of this type, after their use has become well established in high production welding, will be used more and more in maintenance work.

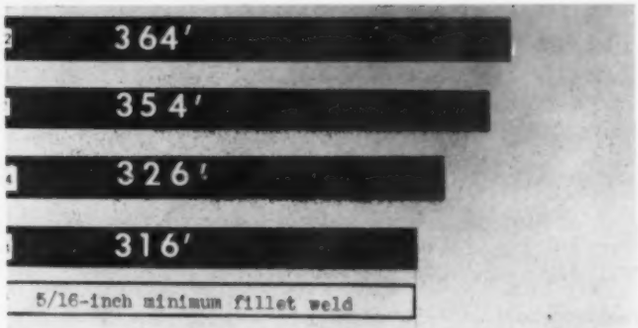


Figure 5 — Feet of ¼-in. fillet welds produced by 50 lb of electrodes shown in Figure 4.

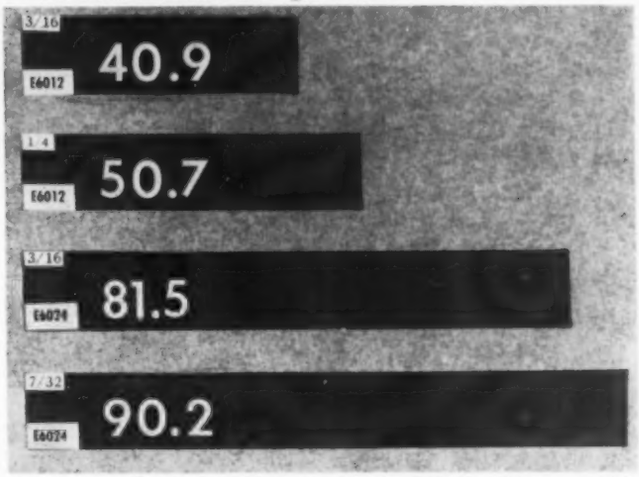


Figure 6 — Comparative feet of ¼-in. fillet welds per welder hour using the two electrodes shown in Figure 4.

SUMMARY

In summary, several mechanized welding and cutting jobs have been described as illustrations of six basic factors involved in the mechanization of such work. Welding and cutting equipment manufacturers are continuously engaged in process development and in machine design to do better work with fewer manhours. The six principles discussed in the paper will furnish steel mill maintenance men with a method for applying such machines to reduce maintenance manhours and therefore costs.

Figure 7 — Typical production set-up for gas shielded electric welding of mild steel indicates the potential of this new process for maintenance work.

. . . . many books could be written on the selection of proper bearing materials . . . . plain bearings have the advantage of not being sensitive to contaminants, give good operation under high speed, pressures and shock and are easy to clean, aline, install, and lubricate . . . . anti-friction bearings are good at low speed, under starting and stopping loads, can handle both radial and thrust loads, have low rates of wear and usually need little maintenance . . . .

Selection and Use of roll neck bearings

By K. E. McHENRY,

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▲ ROLLNECK bearings are used to support and control the motion of a rotating roll while consuming a minimum of power. The large majority of bearings in use for this purpose are plain bearings. Plain bearings are those in which the contacting surfaces revolve, or slide with respect to each other. These include all bearings, either sleeve-type or thrust, that depend on a lubricating film to reduce friction between shaft and bearing.

When properly designed and lubricated, plain bearings develop tapered, hydrodynamic oil films which have tremendous load-carrying capacities. In general, bearings of this type are better adapted to supporting heavy loads and shock loads than anti-friction bearings. This accounts for their continued use as a rollneck bearing in steel mills.

Plain bearings under hydrodynamic conditions have a very low coefficient of friction since it is simply a measure of internal shear within the lubricant film. However, fluid friction increases in proportion to the square of the speed and at high speeds it may be considerable. When properly designed, plain bearings can operate at speeds of 25,000 rpm or more. Under certain conditions, such as a reversing mill, the hydrodynamic film may not be developed. Then boundary lubrication conditions exist, and the coefficient of friction is appreciably higher.

Because of the inherent characteristics of the lining materials and the flushing action of the lubricant, plain bearings are not too sensitive to contaminants. They are also relatively inexpensive and operate very quietly.

Although a bearing may be considered as being only a physical support for a journal, in serving that function it has to have certain attributes such as:

1. Minimum friction under conditions of boundary lubrication.
2. Sufficient plasticity to conform to irregular shafts and to embed solid contaminants too large to pass without rupturing the oil film.
3. Good thermal conductivity to carry away frictional heat from the rubbing surface.
4. Sufficient strength to carry the load and not to squeeze out or fracture by fatigue under cyclic stresses.
5. Be chemically inert to its environment.

Some of these attributes necessarily conflict with each other. No one bearing material meets all the requirements to best advantage. A wide range of bearing materials has been used in rollneck bearings. Some of the most significant materials are as follows: (1) high lead base babbitt, (2) high tin base babbitt, (3) leaded bronzes, (4) phosphor bronzes, (5) composition or fabric phenolic resin, (6) aluminum alloys, (7) arsenic, silver, cadmium babbitts, (8) aluminum bronzes and several others of lesser importance.

To perform satisfactorily as a bearing material, the metal must have certain essential characteristics both with respect to the lubricant used and the type of metal employed in the journal. For many years in the past, metals used in bearings were judged by a relatively few mechanical properties, such as, compression strength, elongation and hardness. From such meager information it was difficult to properly evaluate the limitations of the respective bearing material with the various applications under consideration. It is now recognized, based upon several independent studies in recent years, that any metal or alloy can function as a bearing providing it possesses the following properties.

1. *Fatigue resistance*—Fatigue resistance of both solid and porous bronze or cast iron composition or

carbon graphite bearing are of so high an order as to be of little concern. On the other hand tin and lead babbitts, copper base alloys, aluminum alloy, etc., when subjected to bearing fatigue are found to be quite critical in this respect. In fact this property may often be the controlling factor in the use of a particular alloy. Fatigue resistance is of paramount importance for bearings which are subjected to alternating loads, such as, rollneck bearings.

2. *Non-scoring characteristics*—During the period of starting up or where boundary lubrication is encountered, metal to metal contact is known to occur. The score resistance or anti-seizure charactertistics of the bearing metal under these conditions will be judged on the ability to minimize the damage to the journal. It is believed that the excellent non-scoring properties of the tin, lead and cadmium base alloys is due to a thin non-metallic film which forms very rapidly under these adverse operating conditions.

3. *Compressive strength*—Compressive strength is the ability of the metal to withstand the imposed load without extrusion or cracking. In a bearing with a unit directional load, this requirement is quite important. As the inherent compressive strength becomes less, it is necessary to employ thinner bearing linings to prevent excess extrusion.

4. *Conformability*—The ability of the bearing alloy to conform due to its plasticity to any surface irregularities of the journal and thereby permit a more uniform distribution of load within the bearing proper is known as its conformability.

5. *Embeddability*—This is a measure of the ability of the bearing material to permit dirt or foreign matter which is carried into the clearance base to embed in the bearing surface. Tin and lead babbitts, because of their greater embeddability characteristics are quite often selected at the expense of fatigue life where dirty conditions prevail. The harder bearing materials which have poor embeddability retain the dirt on the surface, thereby permitting an abrasive action to take place with scoring or grooving of the shaft resulting.

6. *Corrosion resistance*—Bearing materials should possess good resistance to the corrosive action of oil deterioration product resulting from oil oxidation when subjected to high operating temperatures. Tin base babbitt has been found to be highly resistant and, as such, is resorted to when other bearings proved to be unsatisfactory. Incorporating inhibitors in the oil as a means of obtaining greater stability toward the formation of these corrosive organic acids is also resorted to as a means of control.

7. *Bonding characteristics*—A prerequisite of any bearing material when bonded to a metal back is to have good bonding or adherence qualities. This characteristic is especially critical on bearings subjected to heavy duty loading conditions. Modern casting techniques have developed to a point where metallurgical bond between the bearing back and bearing metal is relatively easy and economical to obtain.

Designs specifying assumed mechanical bonding aids, such as dovetailing, etc., are in general but a compromise for inadequate preparation of the contacting metal surfaces and are found to be more of a hindrance than an aid to bearing quality. Straight bores for casting bearing material can be effectively cleaned prior to casting, thus resulting in better bonding of the bearing material to its back. Typical examples of the effectiveness of this recommended practice include heavy duty automotive diesel and high speed oil film bearing installations. The elimination of dove tails, etc., reduce bearing cost by effecting a reduction in machining time and bearing metal requirements.

Both the tin and lead base babbitts possess qualities which are conducive to satisfactory service operations. Where employed in the steel industry for the various field application of plain bearings, tin base babbitt is generally preferred for the more critical operations due to its superior bondability, heat conductivity, fatigue resistance to shock loads, and somewhat higher strength at operating temperatures. On the other hand, lead base babbitt usage has been expanded throughout the industry to a point where a considerable saving in tin has been forthcoming. With the inauguration of the tin conservation program, lead base babbitt has been substituted for tin base babbitt in most of the less critical operations where severe pounding or high speeds and temperatures are not a factor.

A considerable amount of lead base babbitt with arsenic or silver added has also been utilized as a substitute for tin-base babbitts. The main object in adding arsenic or silver to lead base alloys is to raise the strength at elevated temperatures. This can be accomplished with the addition of a relatively small percentage of either arsenic or silver. The arsenic tends to lower the ductility somewhat, especially in the presence of tin. The low tin content in turn and also the arsenic tend to lower the bondability. Extreme caution must be exercised to prevent mixing other scrap of high tin content with the arsenic scrap, as the arsenic alloy developed thereby becomes brittle if the tin is much over 2 per cent. Considerable increase in the rate of oil oxidation has been noted where arsenic lead base babbitt bearings had been employed, especially where elevated temperatures are encountered along with higher speeds. Field experience will to a large extent dictate the respective limitations of the general usage of the arsenic lead base babbitt compositions.

Silver also increases the strength of the lead base babbitt at elevated temperatures while showing no appreciable reduction in ductility. Unlike arsenic, silver has no adverse effect on the bondability. The silver alloy is quite stable and can be remelted repeatedly without changing its composition. It is not sensitive to tin contamination during the remelt cycle. However, the expense of this alloy generally prohibits its general usage.

Past research and experience covering babbitted bearing materials have demonstrated that the thinner the bearing liner, the higher the fatigue life of the bearing. It has also been noted, that where the journals are polished smooth or electroplated, the reduction in seizure has given considerable more service life to the bearing.

One of the most common types of rollneck bearings is the "grid-type" bearing. This bearing combines the good surface properties and embeddability of soft bear-

ing alloys with the high strength and fatigue resistance of hard bearing alloys. These bearings usually consist of a bronze or composition grid being placed in a bearing shell, which partially or completely forms the thrust collar, all of which is embedded in a lead or tin babbitt. Grid type bearings have been successfully used in high load applications where dirt is a major offender to successful bearing life.

Composition bearings or fabric impregnated phenolic resin bearings, have been very successful as rollneck bearings. With copious amounts of water being applied to steel rolling mills for cooling purposes, the advent of composition bearings requiring only water as a lubricant became a bearing material worthy of experimentation. Water having a viscosity of only one centipoise, therefore has a tendency to greatly lower the coefficient of friction where used as a lubricant.

Composition bearings have a low heat conductivity, approximately 2 Btu per sq ft per in., thickness per hr, degree F. Heat conductivity for bronze is about 400 to 500 times as great. They should not be used at temperatures in excess of 300 F even with no loads.

In order to operate composition rollneck bearings at their highest efficiency, clean, cool water must be supplied for both cooling and lubrication. This water must be applied correctly and in sufficient quantity, the volume being more important than pressure, and rollnecks should be ground smooth including fillets. Swabbing of the necks with either a mineral oil, or soluble oil during the shutting down period prevents the formation of rust on the necks and thereby minimizes the rate of bearing wear. Automatic spray applications of a soluble oil emulsion on the rollneck at the time of mill shutdown and also before starting up has been found to be of definite benefit to extended bearing life service.

As would be expected, water provides the lowest coefficient of friction when employed as a lubricant for composition bearings. However, on several slow speed applications, the usage of either oil or grease has been completely satisfactory and sometimes necessary. Caution must be exercised in determining the heat dissipation required where oil is used as lubricant, a flow sufficient to carry away the heat generated must be provided. In some instances the insertion of bronze thermo-plugs in holes in composition bearings will assist materially in conducting the heat through the bearing, thereby making possible the installation of this bearing at speeds which would not be possible with the conventional composition bearing. The best applications for composition bearings as rollneck bearings may be found when mill speeds are over 200 fpm surface speed and continuous, plenty of water is available, and the bearing may be protected from contamination by metallic particles.

In recent years, anti-friction bearings have found a place on certain mills as rollneck bearings. Generally speaking, an anti-friction bearing consists of two rings, the rolling elements (ball or roller), and a separator. An exception to this generality is the needle roller bearing which does not have a separator and may or may not have an inner ring.

At low speeds, ball and roller bearings develop so little resistance to rolling that they are superior to plain bearings operating under boundary conditions. At higher speeds, resistance to rolling is comparable to fluid shear in hydrodynamic plain bearings.

Individual anti-friction bearings can support, at the same time, both radial and thrust loads in varying degrees—a characteristic not typical of plain bearings.

These bearings are sensitive to vibration, poor fits, corrosion, and abrasive dirt. When properly installed, however, they require very little maintenance but frequent inspection, and have low rates of wear. They require only small amounts of lubricant, but at exceptionally high speeds they are somewhat difficult to lubricate because the rolling elements have a tendency to channel and throw off the lubricant. When too much lubricant is supplied, the churning action of the rolling elements produces excessive fluid friction.

The life of ball and roller bearings depends on the fatigue strength of the material and decreases as speed and load increase. At high speeds, a certain amount of noise, the result of the rolling action and windage, is characteristic of these bearings.

A rough comparison between anti-friction and plain bearings under varying conditions might be as shown in Table I.

TABLE I

Bearing Comparison

Characteristic	Ball and roller	Sleeve
High speed	Poor	Good
Low speed	Good	Poor
Pressure high-speed	Poor	Good
Pressure low-speed	Good	Poor
Resistance to shock	Poor	Good
Life of bearing	Indeterminate	Determinable
Starts and stops	Good	Poor
Maintenance cost and replacement	High	Low
Anticipation of replacement	None	Good
Lubrication	Difficult	Easy
Lubricant leakage	Easy	Difficult
Cleaning and relubricating	Hard	Easy
Alinement	Difficult	Easy
Expansion provisions	Difficult	Easy
Coupling problem	Yes	No
Installation	Hard	Easy
Precision operation	Hard	Easy

These are very broad statements and will have to be interpreted for any given application. It does indicate however, many factors that one has to weigh before deciding which type of bearing is best.

In conclusion, the most common bearing materials used as rollneck bearings in steel mills are as follows: (1) babbitt type, including grid inserts and thrust collars, used mostly in blooming mills, structural mills, rail mills, and strip mill back up bearings and to some extent in billet mills and bar mills; (2) composition type used mostly in bar mills, and billet mills and to some extent in blooming mills, structural mills, and strip mills, and (3) anti-friction bearings used mostly as work roll bearings in strip mills.

The problem of selecting the proper bearing material is one which may be discussed by writing several books. However, the author hopes he has given enough of the highlights of bearing material selection so that more consideration may be given to the type of bearing and its application when the next bearing fails.

THE MECHANICS OF LUBRICATION

By
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Most desirable type of lubrication is fluid film . . . . dry lubrication is accepted when the lubricant may transfer abrasives to the bearing surfaces or when temperatures are high enough to break down the lubricant . . . . boundary lubrication has its field primarily in ball and roller bearings.

▲ LUBRICATION functions under three basic conditions or combinations of conditions, irrespective of the mechanisms involved. These may be listed as follows:

1. Dry lubrication.
2. Boundary lubrication.
3. Fluid film lubrication.

The engineer must thoroughly recognize in his design the mechanism of lubrication in these three categories before he can produce a successful machine. All too often, the empirical formulae for design are accepted without the broad knowledge of how they came about or whether or not they can be advantageously modified.

DRY LUBRICATION

It is well understood that dry clean metal surfaces having relative motion to each other, weld, gall and score. Some equipment can be run dry if a solid lubricant is used. This can be a sulphide, oxide or chloride of the metal part formed right on the surface by corrosion. This film is a lubricant in the sense that it prevents galling and rapid destruction of the surface even though it does permit gradual erosion of the metal. Many machines are operated successfully with no lubricant, as such that would fail in a short time if fluid lubricant were applied. The reason is that the fluid lubricant would collect abrasive dirt and apply it to the gear or bearing as a lapping compound. Experience has dictated that in cases such as the following it is best to run dry:

1. Open bull gears and pinions on coal and ash handling equipment.
2. Exposed drag line conveyor gears and parts.
3. Switchgear, small power servomechanisms and controls.
4. Some oven and conveyor chains and bearings.

When such mechanisms are run dry, the abrasive dirt falls away from the moving parts with a minimum of damage. The moving parts should be as hard as the design and materials will permit. A lubricated pinion and bull gear driving a drag line conveyor, subjected to cement dust and debris from the floor was worn out in three months. When this was replaced with a hardened steel pinion running against a chilled cast iron bull gear with no lubrication, it ran over two years.

Switchgear, servomechanisms, variators, etc., are often exposed to dirt. If they are lubricated with oil or grease, they may become gummed and inoperative. Contacts become fouled with consequent arcing and pitting. These things should be run dry.

Oven equipment usually runs better dry if the operating temperature is high enough to break down oil or grease. The necessity of applying lubricants frequently, cleaning out oxidized oil, or using costly synthetic lubricants costs more than replacing worn parts when no lubricant is used. Solid lubricants such as graphite, mica, soapstone, zinc oxide and molybdenum disulphide are also successfully used in these applications. They may be dispersed in a grease, oil or other fluid, or applied dry. In any case, the carrier is volatilized and the solid lubricant does the job of keeping the metal surfaces from galling. Molybdenum disulphide has the advantage over the other solid lubricants mentioned in that it has a chemical affinity for the metal surface and therefore, stays in position longer than the other materials.

Sometimes a surface treatment of manganese-iron-phosphate is used to prevent galling. This performs the same function as any of the other solid lubricants. It is well to remember that any of the solid lubricants are lapping agents. They will cause gradual wear of the bearing surfaces. However, their function is to prevent galling and seizing of moving parts that cannot be lubricated for one reason or another with oil or grease.

BOUNDARY LUBRICATION

Boundary lubrication is a region of semi-lubrication in which some wear, high friction and incipient failure may be expected. This is a region where ball and roller bearings have their greatest usefulness. The condition exists where parts have little relative motion, high loads, or where the moving parts travel in parallel directions. The use of plain bearings should be avoided if possible under these conditions. If it is not possible

to avoid the use of plain bearings, there are some things that can be done to alleviate the situation.

Selection of bearing materials and preparation of the surface are important. Hardened steel against cast iron, or cast iron against cast iron, make good bearing pairs if lubrication is always available, but in the event of rupture of the oil film a severe, if not complete failure results. High lead-bronze and the babbitt metals are much safer to use although they are more expensive and the babbitt is subject to fatigue, lack of bonding, and deformation. Surface finish of gears operating under boundary lubrication is very important, because the lubricant films are so thin that asperities of rough surfaces will penetrate the film and cause welding or galling. It is also important to break in gears very carefully if they are expected to carry heavy loads so that the mating surfaces will become smooth and perfect.

There is a choice of five types of lubricants that are suitable for boundary conditions:

1. Lightly treated petroleum oils which will contain the maximum of unsaturates which have an affinity for the metal. Highly refined petroleum and synthetic oils do not function well under boundary lubrication, as they have little wetting ability.
2. Petroleum products which are polar in nature, i. e., mild extreme pressure lubricants.
3. Greases which are polar in nature. In addition the soap and oil resists being displaced.
4. Lubricants containing solid fillers, such as graphite, talc, mica, molybdenum disulphide, etc. These lubricants are normally only used on rough equipment subject to abusive operating conditions, such as bulldozer tracks, etc.
5. The fatty oils, such as lard, castor, rape seed, etc., are polar in nature and are excellent lubricants for boundary conditions. They are little used because they permit bacteria growth, they oxidize readily to hard varnishes, and they are relatively expensive. They are sometimes compounded with mineral oils to minimize their disadvantages and still retain some advantages.

FLUID FILM LUBRICATION

The surfaces are separated by thick oil film in this region. The designer should strive for this type of lubrication as failure and wear can only occur through loss of lubricant or metal fatigue. In this region we are only concerned with the following problems:

1. A reliable means of supplying the lubricant to the bearing in excess of the bearing demand.
2. A means of retaining the lubricant, and preventing leakage.
3. The elimination of oil grooves and application of correct geometry so that the lubricant will exert the maximum pressure in the load zone to separate the metal surfaces.
4. A sufficient supply of lubricant should be provided to maintain thermal equilibrium, where rubbing speeds are high, or where heat is induced. Temperatures above 150 F require preventive maintenance programs which add to the cost of operation.
5. The shaft center should not run too close to the bearing center, as we are likely to run into an unstable condition where the shaft center follows an elliptical path around the bearing center at one half the rpm.

Machine parts operating in the thick film region do not wear except in starting or stopping, or where debris that is thicker than the oil film passes through the parts. This debris may be mill scale, welding beads, rust particles, or dirt from the surrounding atmosphere.

The oil film thickness is dependent upon: the bearing clearance, the viscosity of the lubricant, the surface speed, and the load. There is an optimum clearance. Too small a clearance decreases the thickness of the oil film and load carrying ability as the shaft and the bearing approach parallel motion. Too large a clearance decreases the area of fluid film pressure, thus increasing the unit load with a consequent decrease in the thickness of the oil film. It must not be assumed that we can arbitrarily use a high viscosity lubricant to provide a thick oil film. Viscosity is the friction of a lubricant and as such generates heat. Any mechanism is only capable of dissipating heat at a given rate per degree rise in temperature. We therefore should select a viscosity which will permit of reaching thermal equilibrium below 150 F. If perchance the final viscosity is below 65 SSU we should have a means of cooling to prevent metal to metal contact upon stopping. Although for special applications there has been considerable propaganda concerning high viscosity index oils, those that thin out least with temperature, it is only the remarkable property of petroleum oils to decrease in viscosity with increase in temperature that permits us to operate under widely varying conditions with only a few viscosities. Oil coolers or other means to assist in dissipating heat must be provided for high speed bearings, or where heat is induced for two reasons.

1. An uncontrolled temperature rise permits oxidation of the oil giving rise to frequent oil changes and the likelihood of resins and varnish formations, leading to oil failures, or at least to extensive cleaning of the oil system.
2. The lubricant may decrease in viscosity to the point that it will not separate the moving surfaces as the machine comes to rest.

ROLLING FRICTION

Rolling friction as it occurs in balls, rollers, and truncated cones is one phase of boundary lubrication which finds many useful application. Friction occurs between the rolling elements, and their retainers or cages. Those bearings without retainers have friction between the rolling elements as the adjacent surfaces are moving in opposite directions. In addition there is considerable sliding, spinning, and skidding between the rollers and the races. A ball with point contact has no area to support a load. A roller with line contact has length but no width, and therefore has no area to support a load. They both therefore must deform in order to support a load. It is the deforming of the rolling elements and their races which causes the metal to fatigue, and the bearing to fail irrespective of the lubricant. A ball or roller bearing only needs enough lubricant to make up for that lost by evaporation or migration. The Hertz equation will show that the load

at point of contact of the rollers is far above that which can be supported by an oil film. We therefore only lubricate where there is a differential in speed between the parts. Many bearings are lubricated with grease as it is effective and easily retained in the housing. A grease that adheres to the bearing may be used where speeds are low. A grease that channels should be used for high speeds to prevent excessive working of the grease, and serious temperature rise of the bearing due to the viscosity of the grease. The rule of thumb for oil-lubricated anti-friction bearings is to use the same viscosity of oil for the operating conditions, as you would for a sleeve bearing. However, in almost all cases, the bearings will perform well on all viscous oils. Dirt of any sort is extremely detrimental as it destroys the highy finished surfaces, and failure will be rapid. Any lubricants containing fillers, such as, graphite, talc, mica, etc., should be used with extreme caution. Not only is there a polishing action that wears the bearing, but frequently the filler builds up between the rollers and their spacers, actually forcing them apart with consequent bearing failure. Ball and roller bearings are precision pieces of equipment, and failures usually occur because of a neglect of this consideration. Very seldom does a bearing reach its design life. We will list a few of the more general causes, most of which can be corrected by suitable design considerations:

1. Excessive thrust due to lack of provisions for expansion as the equipment heats up. This condition would largely be eliminated if designers would anchor their shaft with a ball bearing, and use a roller bearing on the other end which permits the shaft to move transversely.
2. Spinning of the outer race in the housing. When two ball bearings are used to mount a shaft, one must have a sliding fit between the outer race and the housing. Frequently the hardened steel outer race has less friction with a cast iron housing than does the bearing. As a result the outer race rides on the housing as a plain bearing.
3. Brinelling of the bearings due:
   a. Driving on and off, not only the bearing, but such auxiliary equipment as couplings, and gears.
   b. Equipment standing idle where vibration occurs.
   c. When applied to mechanisms with limited motion. The motion should be such that the balls or roller turns at least 180 degrees. There is a little evidence that we may be able to help somewhat in the cases of b and c by the use of suitable lubricants.
4. Preload of the bearing due to forcing it on an oversize shaft, or an out of round housing. This frequently occurs where housings are split. Possibly the greatest single cause is when a taper, with its large mechanical advantage, is used to lock a bearing in place.
5. Dirt at time of assembly, inspection, or during operation.
6. Corrosion takes a large toll in spite of excellent lubricants. We can only pack slow speed bearings full of lubricant to exclude moisture, and corrosive fumes.

It is hoped that this brief paper may stimulate those interested in lubrication to further knowledge. There is a wealth of material available in the literature and the personnel of the technical societies devoted to lubrication.

. . . . quality control of lubricants has helped in a preventive maintenance program . . . . engine overhaul is set by oil laboratory data, resulting in planned delays instead of breakdowns . . . .

A Practical Solution to a fuel and lubrication problem

By C. R. BURTON, Superintendent of Maintenance,

Hibbing-Chisholm District, Oliver Iron Mining Division, United States Steel Corp., Hibbing, Minn.

▲ THE selection and proper use of lubricants for stationary and mobile mining equipment which operates around the clock exposed to the elements presents a lubrication problem. The iron formation of Northern Minnesota is rather narrow and deep and extends some 250 miles from West to East. The Hibbing-Chisholm district of the Oliver Iron Mining Division of the United States Steel Corp. is responsible for mining operations in an area approximately three miles wide and 20 miles in length. The mining operation in this area is broken up into smaller individual operations over the entire length.

In order to better understand the lubricant problem, it is first necessary to describe the equipment used and second, the conditions under which it operates. Many types of equipment are used to mine iron ore such as 1000 to 2000-hp diesel-electric locomotives, 300 to 400-hp, 30-ton trucks, 15 to 20-ton tractors, 40 to 50-ton

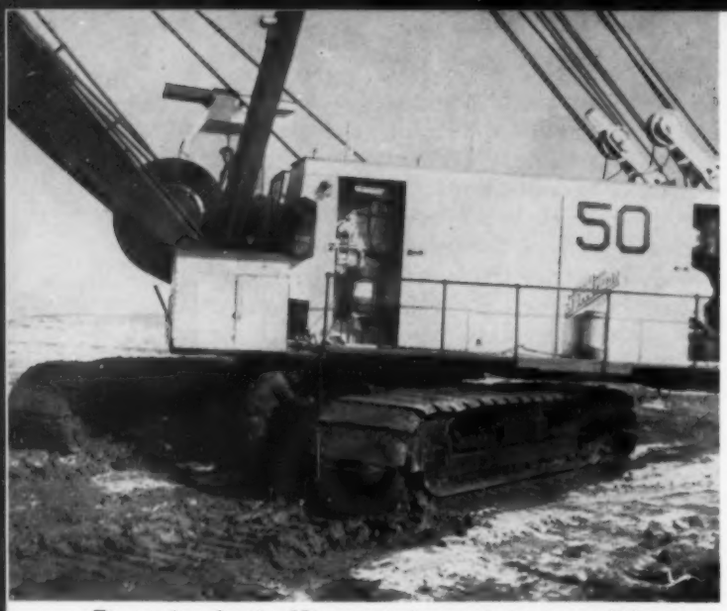


Figure 1 — In the Minnesota iron mining area, it is necessary to keep heavy equipment going under all types of conditions.

diesel and diesel-electric locomotive cranes, road patrols, diesel-engine powered shovels up to 5½-yd dipper capacity, electric shovels up to 8½-yd dipper capacity, service trucks, loaders, portable and stationary diesel, gas and electric air compressors and many other types of powered mechanical equipment. In addition to the mobile mining equipment, there are semi-permanent stationary installations for shops, underground mine hoist installations, plants to crush, screen, and concentrate ore, etc. The majority of the mining equipment operates seven days a week, 24 hr per day. The men are on a 40-hr per week schedule, which means that the equipment is operated by a number of persons during a week. This constant changing of operating personnel necessitates a good control method for lubricant handling and application in order to eliminate the mixing of lubricants and to assure the correct application or renewal of lubricants when required. Another obstacle to be overcome in properly

Figure 2 — Lubrication instructions are posted on the equipment.

lubricating mining equipment is the operating conditions. The majority of mining equipment is started and operates out-of-doors in sun, rain, and snow in temperatures ranging from plus 100 F to minus 40 F.

The lubrication control program now in use by the Hibbing-Chisholm district of the Oliver Iron Mining Division was started by first analyzing the lubrication requirements of all equipment in use and comparing what was required with what was being used. It was first discovered that over 65 different oils and greases were used for winter and summer operations. By evaluating and consolidating, this number of lubricants was cut to 12 different products. This consolidation of lubricant brands and types has had a threefold benefit: (1) it minimizes the chance of the mixing of lubricants, (2) it yields a benefit through volume purchasing of lubricants, and (3) it requires less inventory and accounting expense.

The second step in establishing the controlled lubrication program was to make sure that the people responsible for lubrication knew what lubricant was to be used and where. This educational part of the program was attempted in the following manner. On machinery which presented complicated lubricating problems, maintenance engineers were assigned to the job of making schematic charts showing each grease or oil check point and indicating the kind of lubrication, amount per application and the frequency of application required. These charts were posted on the equipment together with a list of the lubricants to be used on the particular equipment. This list is used in ordering lubricants from our central storage points.

A sound slide film was made showing the correct method and the importance of lubricating a particular type of equipment. The aid of the operating foremen in the various mines was enlisted by having meetings at which the cost of improper lubrication was emphasized by citing costs of repair which could have been eliminated on the equipment in their charge by proper lubrication and by showing them the film slide on how and where the lubrication should be done. The workmen directly responsible for the lubrication of machines were then called in and instructed with the film slide, pointing out the costs of faulty lubrication and what was being done to make their job easier.

A program has been instituted in connection with employees starting a job as an oiler where the new man spends a day with the foreman in charge of maintenance of the particular equipment and with the lubrication foreman and the safety department. There is a follow-up, on the job, checking the new man's performance. The lubricator's job is being made easier by the installation of the lubrication charts, power greasing equipment, both air and electric barrel pumps with retractable grease hose reels, centralized lubricating systems and better lubricant handling facilities. In some instances, for mobile equipment operating "around the clock," a lubrication truck is provided carrying the necessary lubricants, to go to the equipment on the job and aid in the lubrication.

Portable oil houses have been constructed for use on temporary jobs. These oil houses are equipped with power dispensing equipment for water, oil, grease, fuel and air.

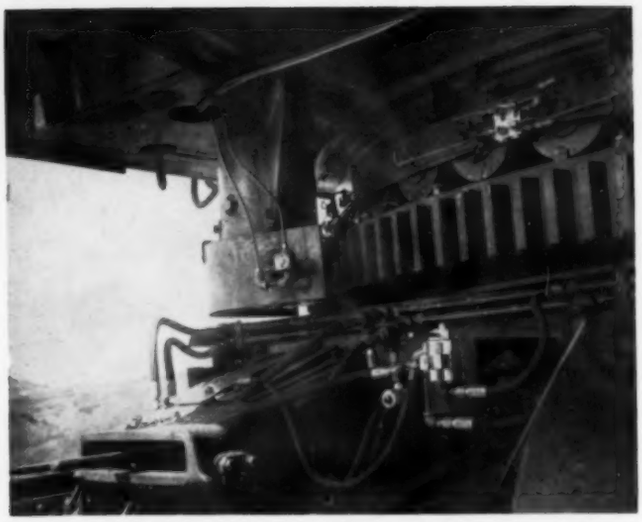


Figure 3 — Full advantage is taken of lubricating systems.

The third phase of the controlled lubrication program involved the assurance that the best lubrication was being obtained for the least amount of expense. First, engine crank case oil, one of the large expense items in the cost of lubricants, was checked to determine whether the recommended change period was correct. In order to decide whether the change period for crankcase oil was correct, a program was set up to take a sample daily from a representative group of each type of equipment. This sample was then analyzed to determine whether it would meet the minimum specification required for proper lubrication of that particular type of equipment. It was soon discovered that no standard oil change period could be set up which would cover all engines in any particular type of equipment. The change period recommended by the engine manufacturer is the period that is best for the average engine. It does not mean that if the recommended change period is observed on all their engines, no operating difficulties will be experienced due to faulty lubrication. Some engines may dilute the oil to a dangerous extent, due to faulty injection or poor carburation, in a relatively short number of hours, while others may develop water leaks into the lubricating system or contaminate the crankcase oil due to engine blowby or faulty operating temperature. Still other engines may continue to operate for hour after hour and the oil will remain in a "good as new" condition. It seemed reasonable to expect that if a simple check could be made daily of the crankcase oil condition in all engines it would be possible to decrease the oil change frequency and to minimize the danger of "losing" an engine due to faulty crankcase oil, as well as to extend engine life by reducing wear.

Utilizing the experience of lubrication experts from various oil companies, the following procedure was developed. Oil samples are withdrawn daily from all equipment that has been operating continuously and the samples are sent to an oil analysis laboratory. The sample of oil is taken by using a special suction gun which was developed for the purpose. Some installations are provided with a pet-cock drain where a representative sample may be taken. However, we prefer the sample gun method because it eliminates the danger of oil loss due to vibration breaking of auxiliaries

Figure 4 — Crankcase oil is sampled to determine time of replacement.

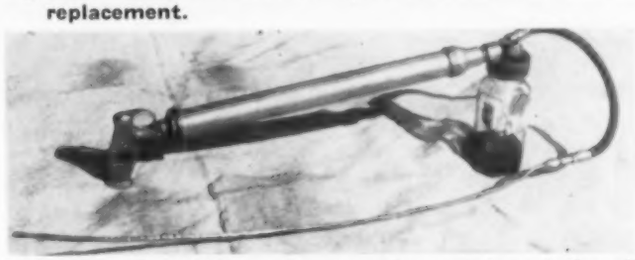


Figure 5 — A special suction gun is used to get the oil sample.

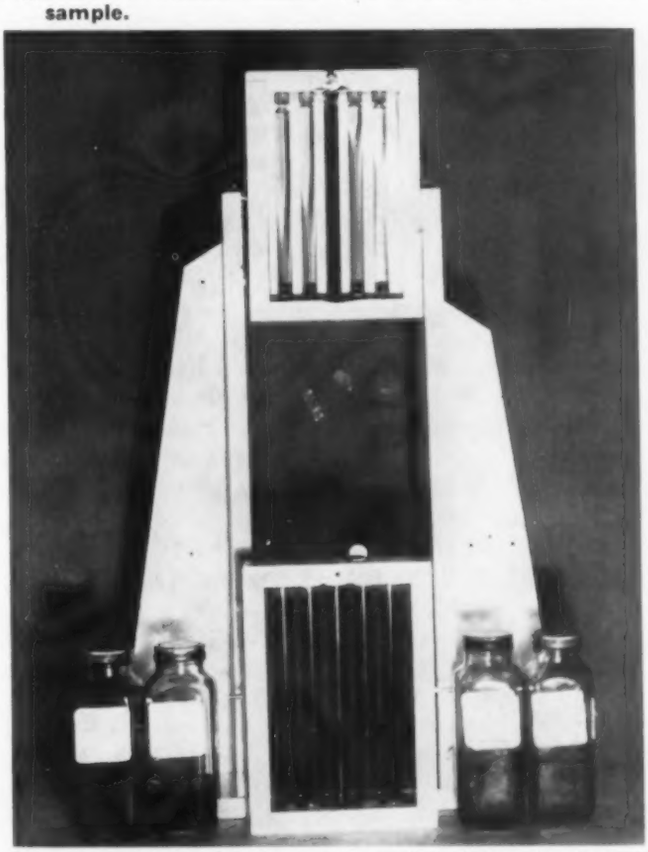


Figure 6 — A simple ball test is used to determine loss of the viscosity.

to the pet-cock drain or loosening of the pet-cock valve. It also avoids contamination of the sample.

Two simple checks are then made on the used crankcase oil: the first is a viscosity determination in which a small sample of the used oil is placed in a test tube

with a steel ball. This tube is then placed in a rack along with other tubes containing samples of the same type of new oil of different viscosities. For example, if the used oil being checked was originally a SAE 30 oil, the samples of new oil would be SAE 30, 20, and 10. The falling sphere comparative rack is then tipped over and the dropping speed of the steel ball is noted in comparison with that of the steel balls in the samples of new oil of the different viscosities. The used oil is then rated as a plus or minus 30, 20, or 10, depending on the relation of its viscosity to the viscosities of the samples of new oil.

The sample is then diluted 50 per cent with benzine in a special calibrated tube and is centrifuged in a centrifuge for 12 min. After spinning, the percentage of solids, now accumulated in the end of the tube, is noted and recorded. The results of these two simple tests are then recorded on one sheet for comparison. The figures obtained from these two tests for the various samples of used oils are then compared with standard allowable limits of viscosity and sediment which have been established from past experiences. The viscosity limit is 10 points lower than the unused oil. For example, if the comparative viscometer indicated that the viscosity of a used oil sample was approximately the same as that of a new SAE 20 oil and the original oil had been an SAE 30, the unit would be allowed to operate. However, if the viscosity of the sample tested lower than the limit, steps would be taken to bring the equipment unit in immediately for an oil change and check-up. The limits on sediment have been set at 0.6 per cent by volume for a truck, tractor, grader, or car engine, and 0.14 per cent sediment by volume for a diesel locomotive or similar unit crankcase oil. If the sediment in the used oil sample is found to be above the limits set up, the oil laboratory calls for a cartridge change in the lubricating by-pass filter.

The lubrication foreman has developed a simple method for checking the metallic contamination in used crankcase oils. By breaking down benzol insolubles into oxides, sulphates and chlorides and adding an extracting solution, it appears possible by the use of indicators to determine the presence of metallic contaminations in lubricating oils.

The general outline of how this is accomplished is as follows: 50 cc of used oil is mixed with 50 cc of benzol, shaken vigorously and then filtered. The filter paper which contains benzol insolubles is then treated with 5 cc of H_2So4 and 5 cc of Hc1. This is then heated until all acids have been removed. To the residue, a 10 cc application of extracting solution is mixed and filtered. The extract produced is now ready for testing indicators necessary to produce color combinations indicative of metal contaminations. The metals that may be detected by this method are iron, aluminum, copper, lead, and potassium. The success of any oil testing program is dependent upon the speed and accuracy of the results obtained. The above testing procedure is both fast and accurate as high as 30 used oil samples have been run in two hours. If the same tests were to be made without the aid of a spectograph, it would require four to five days to complete.

From the posting sheet, on which all the samples

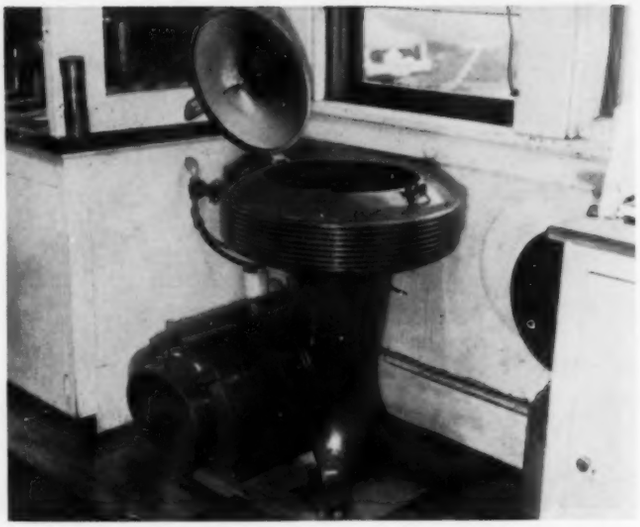
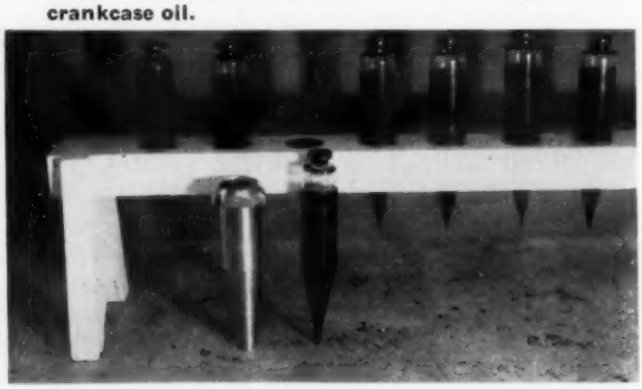


Figure 7 — Centrifuge is used to determine sediment.

for that day are posted, the laboratory technician posts to an individual unit engine card the results of the sample examinations and the number of operating hours. A call sheet is then made out for each mine, garage or foreman, depending on the condition, using the complete sample posting sheet and the individual engine card sheet as a guide which lists any periodic check to be performed and the necessary measures taken to correct the faulty oil condition. Some of the items found on this sheet, that have been previously set up by the foreman in charge of the equipment, are: grease job (based on operating hours), oil change, oil filter cartridge change, injection system check, check for fuel, water or hydraulic oil or lubricating oil leaks, special filter checks or changes, or any other item the foreman in charge of the equipment may have set up on an hourly basis. The information from this sheet is then forwarded to the foreman, garage or shop, depending on how the work is to be handled; the work required is completed and the noted sheet is returned to the oil laboratory. Every two weeks the oil laboratory prepares a report that is sent to the lubrication foreman, truck and tractor foreman, locomotive foreman, and superintendent of maintenance. This report contains a two-week summary of the crankcase oil condition of equipment under the supervision of the oil laboratory. The report includes such items as total engine operating hours during the period the report cov-

Figure 8 — Sediment limits are 0.6 per cent by volume for truck, tractor, and car engines, and 0.14 per cent by volume for diesel locomotive or similar equipment's crankcase oil.



ers, crankcase oil added, number of oil changes, number of filter changes, hours on the oil since last changed, and hours on the filter since last changed. The report also tabulates the engine crankcase oil consumption in quarts per hour of each engine for a four-month period. This same report tabulates the units that had crankcase oil dilution or high sediment and fuel oil consumption. The report gives the maintenance foreman a very good picture of the engines under his care and allows him to plan for engine change-outs and overhaul in advance. When engines consume one quart or more per hour of crankcase oil, they are changed out or overhauled.

At the present time, there are 260 pieces of equipment for which the oil laboratory handles the control of the lubricants. The oil laboratory also analyzes incoming shipments of fuel oil, recommends cooling water treatment, and analyzes greases and oils to determine whether they meet the specifications required.

A continuous testing program is in progress using single cylinder diesel test engines to screen fuels and lubricants. A fuel or lubricant to be tested is first run for 100 hours in the test engine with a cycling load of 10 minutes full load, 20 minutes idle. After the test run, the engine is dismantled, the rings, valves, and bearings weighed and checked for loss, and carbon deposits evaluated. If the fuel or lubricant performs satisfactory, the product is then field tested in a few pieces of equipment before approving its use in similar equipment. Many interesting results have been obtained from these test engines. In an experiment conducted in cooperation with a leading fuel and lubricant producer, it was found that each fuel should be checked as to its performance in an actual engine because in some instances we have found that fuels with a relatively high sulphur 0.4 to 1.0 per cent caused less wear than other fuels with sulphur contents in the so called low sulphur range 0.0 to 0.4 per cent. In the limited testing that has been done it has been found that certain additives added to high sulphur fuels allow them to perform in an engine equal to or better than some premium low sulphur fuels. We feel that many combinations of fuels and lubricants may be had that will work satisfactorily in an engine and the single cylinder test engine allows some preliminary screening for these satisfactory combinations. The cooling water is sampled periodically, tested, and reported in the same manner that the lubricating oil is handled.

The control of lubrication is one item in a preventive maintenance program which is in effect in the Oliver Iron Mining Division, United States Steel Corp. This program is aimed at increased production with less downtime of equipment and at keeping repair and maintenance costs at a minimum. The quality control of lubricants has had good acceptance by the maintenance foremen, because it eliminates clerical work that would have to be done by him or his mechanics, besides giving him a check on engine conditions. The maintenance foremen are now changing-out or overhauling engines based on an oil laboratory report on oil consumption. This means a planned delay instead of a breakdown to the mine operators. You may wonder how the expense of such a program is justified. It may be stated that the saving afforded the company due to volume purchasing and decreased oil consumption has more than paid for the expense involved in the described program. Decreased engine wear, which means lower repair and maintenance costs and increased mine production, is an additional benefit derived from the program.

DISCUSSION

PRESENTED BY

J. R. SADOWSKI, Lubrication Supervisor, Crucible Steel Co. of America, Syracuse, N. Y.

C. R. BURTON, Superintendent of Maintenance, Hibbing-Chisholm District, Oliver Iron Mining Division, United States Steel Corp., Hibbing, Minn.

J. R. Sadowski: Mr. Burton has done an excellent job in limiting the number of lubricants used, to only twelve different types, especially when one considers the wide ambient temperature conditions encountered. I would like to have him elaborate on that subject a little more. I would like to know what precautions he has taken in regard to the storage of his fuels and lubricants, primarily with regard to moisture condensation due to temperature changes.

I noted that Mr. Burton has found it advisable to make an individual check of each piece of equipment to determine the oil condition and the engine condition as well. I presume it is the latter that he is primarily interested in; however, I would like to know how often oil changes are made and whether these oil changes are made more frequently in the winter than in the summer.

C. R. Burton: Relative to the selection of lubricants for cold weather, with the degree of temperature change that we have, we use a winter and summer grade of lubricant and fuel. We switch over in the fall. The fuel that we use has a pour point of a minimum of thirty-five degrees below zero and some fuels go as low as fifty degrees below.

The lubricants are extremely light in grade due to the fact that they have to have the low temperature pumpability. The lubricants, although light in viscosity, are extreme pressure greases.

As to the fuel oil storage, that is stored outdoors in tanks, and the fact that we change over in the fall means we do sacrifice something with regard to burning lighter fuel for a period of time. However, it eliminates the possibility of getting caught with a tank full of fuel that could not be pumped. We also have fuel filtering at each tank facility.

We make frequent checks on our tanks in the spring and fall in order to eliminate the water and condensation problem. We are not bothered by condensation during the winter.

As to oil change, I would say there is a little more frequent changing in the winter due to longer periods of idling. We have locomotives that have operated in the neighborhood of from 20,000 to 30,000 hours on the same lubricant and trucks that have gone as high as from 2000 to 3000 hours without an oil change. We have some eight tractors that have operated in the neighborhood of 6000 hours without an oil change.

Ladle cranes were rebuilt to obtain the additional capacity required by larger open hearths at Granite City Steel . . . . a detailed analysis was made which resulted in a minimum of rebuilding but nevertheless gave cranes which have performed satisfactorily with no increase in maintenance cost per ton of steel handled . . . . time was also saved by the rebuilding operation . . . .

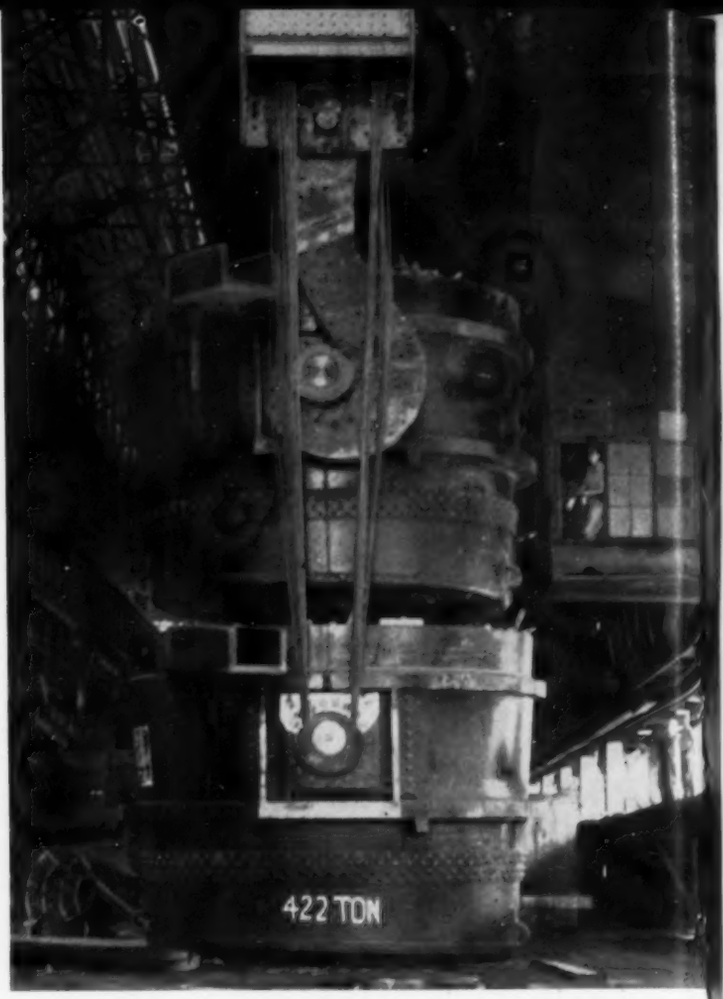


Figure 1 — Rebuilt cranes successfully handled the high test loads.

INCREASING CAPACITY OF LADLE CRANES

By EUGENE WHITAKER,

Chief Mechanical Engineer, Granite City Steel Co., Granite City, Ill.

▲ IN the latter part of 1950, Granite City Steel Co. initiated a program of expansion and modernization which was designed to double its capacity of 650,000 net tons per year. A major part of this program consisted of increasing the open hearth facilities in its No. 2 open hearth shop. The proposed increase was to consist of three new 285-ton furnaces, increasing the capacity of the four existing 210-ton furnaces to 250-ton capacity and additional auxiliary equipment.

The existing equipment on the pit side consisted of two ladle cranes rated at 270 net tons, which had been furnished under the World War II DPC program.

Under the new expansion program, the company planned to purchase one new 350-net ton ladle crane primarily to handle the heats from the new 285-ton furnaces.

The existing ladle cranes were to be used to handle only the heats from the proposed 250-ton furnaces. With a metal load of 250 ton, an estimated ladle and ladle lining weight of 90 ton, it was obvious the existing ladle cranes' rating of 270 net tons would be greatly exceeded. It was therefore decided to investigate the possibility of revamping the existing cranes to handle the additional load.

The 270-ton ladle cranes are the four girder type with the main hoist on the two outside girders and a 40/10-ton auxiliary hoist on the inside girders. The girders are riveted box type construction with equalizer trucks carrying the 16 bridge wheels. The bridge is driven by two 135-hp motors, one located at the center of each bridge girder.

The main hoist was to be the focal point of the inves-

tigation and a description of mechanical arrangement and the conditions under which it must operate are as follows:

Two 135-hp, 410-rpm main hoist motors each drive through a worm gear reducer with a ratio of 15:1. The worm gear is free to rotate on the main hoist pinion shaft which passes through the worm reducer housing. Keyed to end of the pinion shaft is a pawl holder which carries six pawls that engage with a 25-tooth ratchet wheel. However, only one pawl is engaged at any one time. The hub of the ratchet wheel is keyed to the hub of the worm gear which also extends through the worm reducer housing. With this arrangement, the ratchet wheel is made to turn when the worm gear turns, and the pawl holder is made to turn when the pinion shaft turns. The pinion shaft in turn drives the main hoist drum gear.

Under all normal operating conditions there is an overhauling load tending to rotate the main hoist drums.

Braking is accomplished by two 24-in. magnetic brakes on each motor. One is located between the motor and reducer and the other is located on the commutator end of the motor.

Condition I—When both motors are operating for hoisting or lowering at the same speed and correct direction, one pawl remains engaged with a tooth of the ratchet wheel and the ratchet remains inoperative.

Condition II—When hoisting with only one motor, the other motor at rest with its two brakes applied, the load can be hoisted. Under this condition, the worm wheel and ratchet wheel on the dead motor side are held stationary by two 24-in. brakes on the dead motor. The pinion shaft and pawl holder rotate under this condition in the stationary ratchet wheel causing the pawls to disengage and allowing the pinion shaft to rotate.

Condition III—When one motor is at rest, it is not possible to lower the load with one motor under this condition, because the worm wheel and ratchet wheel are held stationary by the two brakes on the dead motor. The pinion shaft and pawl holder rotates until a pawl engages a tooth of the ratchet wheel, thus locking the pinion shaft which in turn locks the drums and the other pinion shaft. When this condition exists, the driving motor rotates its ratchet wheel around the stationary pawl holder causing the pawls to disengage and freeing the driving motor so it can rotate.

In order to lower the load with one motor, the brakes on the dead motor must be released. This is accomplished by closing a special switch which transfers the operation of these brakes to the circuit of the operating motor, thus freeing the mechanism so the load can be lowered.

Condition IV—When lowering normally with two motors in operation, if the overhauling load becomes zero, the pinion shafts stop revolving due to loss of the overhauling load. An example is when the lifting beam is resting across the top of a ladle, the lead line pull of the ropes to the drums becomes zero.

Under this condition, the driving motors cause the ratchet wheels to rotate around the stationary pawl holders causing the pawls to disengage and prevent further rotation of the drums. This prevents further playing out of rope and thus prevents the ropes from jumping out of the drum grooves and sheaves.

Analysis of the hoist drive shows that with two motors operating for hoisting or lowering, the load is divided equally between the two motors and resulting stresses are equally divided between pinion shafts.

Under Conditions II and III, when only one motor is operating, the entire load and resulting stresses are transmitted through the one pinion shaft whose ratchet gear pawl is engaged to support the load.

Maximum stress calculations in the component parts and load distribution in the main hoist trolley were based on loads obtained under Conditions II and III.

The initial calculations were based on the following assumptions:

a. Metal load—500,000 lb
b. Ladle, ladle lining and other parts—180,000 lb.
c. Existing ladle hooks (2)—24,000 lb.
d. Total dead weight of lifting beam—36,000 lb.

Total design load—740,000 lb.

The AISE Crane Standard No. 6, Revised May 1, 1949, was used as a guide for determining the allowable stresses, stress factors, efficiency factors and so forth, where applicable.

A very careful and detailed analysis was made of the loads and stresses on each component of the main hoist.

Part I, Table I, shows the tabulated results of the initial investigation showing which parts would be overstressed and have to be redesigned. All other parts were apparently within the allowable stresses.

Part II, Table I, indicates how the parts were redesigned and the estimated stresses in each individual member.

Table I also shows the main hoist reeving consisting of 44 parts of 1⅛-in. diam wire rope to be overstressed 82 per cent, resulting in a factor of safety of only 5.54 when in motion. The usual factor of safety used is ten with a minimum of eight for cranes handling hot metal. In order to secure the desired safety factor with the proposed loads, it would require an increase to 60 parts of 1⅛-in. diam wire rope, or 52 parts of 1¼-in. diam rope. The 52 parts of 1¼-in. diam rope was chosen for the following reasons.

a. Higher capacity based on ultimate strength.
b. Higher reeving efficiency resulting in lower dynamic stresses.
c. Lower net weight increase due to fewer sheaves being required, and the resulting shorter shafts, supports, etc.
d. A favorable factor of safety of nine for static loads and eight for dynamic loading.
e. Existing 33¾-in. pitch diam sheaves could be remachined for 1¼-in. rope and reused.
f. Lower initial cost.
g. Lower future labor costs when changing ropes.

Increasing the reeving from 44 parts to 52 parts necessitated the following additional alterations:

a. 22½-in. longer main hoist drums, pinion shafts, drum shafts.
b. New sheave support beams to accommodate the additional sheaves.
c. Increasing the width of the main hoist trolley 22½ in. with the necessary alterations to the structural members connecting the main hoist trolley beams.

TABLE I

Loads and Stresses on Crane Parts with Design Load of 370 Tons

Part I — Original Crane Parts

Part	Size	Kind of force and location	Load condition	Material	Yield Point	Maximum Allowable	Load or Stress	Safety Factor Per Cent Allowable
Main hoist wire rope	44 Parts—1⅛-in. diam.	Tension in all ropes	At rest	6 x 37 Steel core Imp. plow steel	107,720 lb°	10,772 lb (FS10)	16,820 lb	157 (FS 6.4)
Main hoist wire rope	44 Parts—1⅛-in. diam.	Tension in 4 lead lines	In motion	6x37 Steel core Imp. plow steel	107,720 lb°	10,772 lb (FS10)	19,490 lb	182 (FS5.54)
Main hoist pinion shaft	6½-in. diam	Bending at pinion gear	2 and 3*	AISI 4140 H.T.	67,000 psi	16,750 psi	25,900 psi	154.5
Main hoist pinion shaft	6½-in. diam	Combined bending and torsion at pinion gear	2 and 3*	AISI 4140 H.T.	67,000 psi	Approximate 13,400 psi	28,300 psi	210
Pinion shaft	6½-in. diam	Combined bending and torsion at ratchet gear	2 and 3*	AISI 4140 H.T.	67,000 psi	13,400 psi	15,000 psi	111.1
Keys (pinion gear)	2—1½ x 1⅛ x 9 in.	Bearing on shaft	2 and 3*	SAE 1040	58,000 psi	14,500 psi	17,250 psi	119
Keys (ratchet wheel hub)	2—1½ x 1⅛ x 5 in.	Bearing at hub	2 and 3*	SAE 1040	58,000 psi	14,500 psi	18,200 psi	126
Pawl (ratchet gear)	1 x 3¼-in. face	Bearing on end of pawl	2 and 3*	Cast steel	30,000 psi	7,500 psi	17,000 psi	227
Pawl (ratchet gear)	2-in. diam	Bearings on socket end	2 and 3*	Cast steel	30,000 psi	7,500 psi	8,750 psi	116.8
Drum pinion	20° stub, 9-in. face, 16-in. PD, 1-in. DP	Tooth pressure at pitch line	2 and 3*	SAE 1045 HT	—	171 hp	190 hp	
Drum bearing cap bolts	4—1 in. diam	Tension	2 and 3*	AISI 4140	53,000 psi	16,000 psi	25,900 psi	162
Sheave pin (lift beam)	1½ x 6½ in.	Bending	Maximum	SAE 1020	43,000 psi	10,750 psi	19,500 psi	182
Main hoist truck wheel axle	7¼-in. diam	Bending at wheel	Maximum	SAE 1020	43,000 psi	10,750 psi	16,850 psi	157
Main hoist truck wheel axle	7¼-in. diam	Combined shear and bending	Maximum	SAE 1020	43,000 psi	10,750 psi	16,900 psi	157.2
Main hoist truck wheel	27-in. diam for 135-lb rail	Load on wheel	Maximum	—	—	95,000 lb	11,900 lb	125
Main hoist trolley rail	135-lb rail	Load on trolley wheels	Maximum	—	—	18,000 psi	32,500 psi	178

Part II — Redesigned Crane Parts

Main hoist wire rope	52 parts—1¼-in. diam	Tension	At rest	6x37 Steel core ex. flex. preformed	132,220 lb°	16,550 lb (FS8)	14,240 lb	86.1 (FS9.28
Main hoist wire rope	52 parts—1¼-in. diam	Tension in 4 lead lines	In motion	6x37 Steel core ex. flex. preformed	132,220 lb°	16,550 lb (FS8)	16,590 lb	100 (FS8)
Main hoist pinion shaft	8-in. diam @ pinion 7-in. diam @ worm	Bending and pinion gear	2 and 3*	AISI 4140 HT	67,000 psi	16,750 psi	13,100 psi	78.2
Main hoist pinion shaft	8-in. diam @ pinion 7-in. diam @ worm	Combined bending and torsion at pinion gear	2 and 3*	AISI 4140 HT	67,000 psi	16,750 psi	13,900 psi	83
Main hoist pinion shaft	8-in. diam @ pinion 7-in. diam @ worm	Combined bending and torsion at ratchet gear	2 and 3*	AISI 4140 HT	67,000 psi	16,750 psi	8,550 psi	51
Keys (pinion gear)	2—1½ x 1⅛ x 10-in.	Bearing on shaft	2 and 3*	SAE 1040	58,000 psi	14,500 psi	10,300 psi	71
Keys (ratchet wheel hub)	2—1½ x 1⅛ x 6 in.	Bearing at hub	2 and 3*	SAE 1040	58,000 psi	14,500 psi	12,100 psi	83.5
Pawl in ratchet gear	1 x 4¼-in face	Bearing at end of pawl	2 and 3*	Cast steel	50,000 psi	2,500 psi	12,000 psi	96
Pawl in ratchet gear	2-in. diam x 4½ in.	Bearing at socket	2 and 3*	Cast steel	50,000 psi	2,500 psi	6,370 psi	51
Drum pinion	20° stub, 10-in. face, 16-in. PD, 1-in. DP	Tooth pressure at pitch line	2 and 3*	SAE 1045 HT	—	204 hp	190 hp	93
Drum cap bearing bolts	8—1¼-in. diam	Tension	2 and 3*	SAE 4140	63,000 psi	16,000 psi	7,980 psi	49.8
Sheave pin (lift beam)	5½-in. diam	Bending	Maximum	SAE 4140	67,000 psi	16,750 psi	10,850 psi	64.8
Main hoist truck wheel axle	8¾-in. diam	Bending at wheel	Maximum	SAE 1020	43,000 psi	10,750 psi	9,600 psi	89.3
Main hoist truck wheel axle	8¾-in. diam	Combined bending and shear	Maximum	SAE 1020	43,000 psi	10,750 psi	9,630 psi	89.6
Main hoist truck wheel	27-in. diam for 175-lb rail	Load on wheel	Maximum	—	—	128,000 lb	119,000 lb	93
Main hoist trolley rails	175-lb rail and 14¾ x ¾-in. bearing plate	Load on trolley wheels	Maximum	—	—	18,000 psi	16,600 psi	92.2

*Hoisting and lowering with one motor.

°Based on ultimate strength.

d. New lifting beam, sheaves, sheave shafts and equalizer beams.
e. Revamp to the main hoist trolley lubrication system for the additional number of lubrication points.

A careful analysis of the forces acting on the main hoist drums during one motor operation revealed a point of special interest. Because of the special condition, there exists an uplift at the main hoist drum bearing on the gear end, which must be resisted by the bearing cap and bearing cap bolts. This uplift exists only at the drum on the "live" motor side. Figure 2 indicated the forces acting on the main hoist during one motor operation.

The forces on drum A tend to rotate it around a reaction line extending from the point of contact of the main hoist drum gear and pinion gear A and the bearing on the opposite end of the drum. By taking a summa-

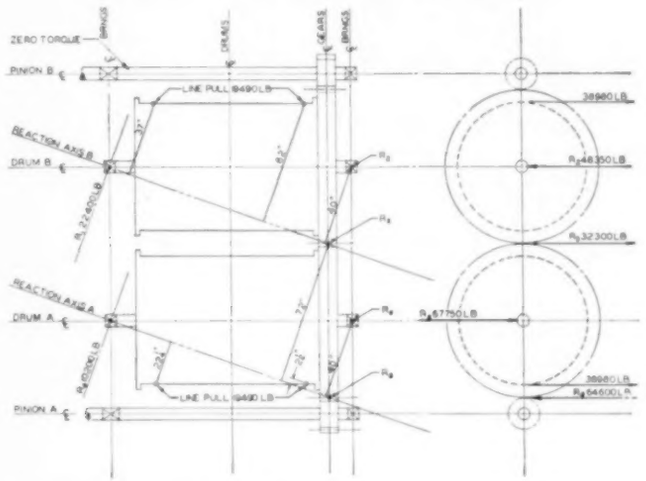


Figure 2 — Forces which act on the drum are shown with one motor being operated.

tion of moments around this axis, the reaction force at R_5 was found to be approximately 67,750 lb. The same analysis can be applied to Drum B to determine the reaction force of 48,350 lb at R_2. Applying one-half the drum weight of 11,240 lb each of these reactions, gives a net reaction of 59,590 lb at R_2 and 56,510 lb at R_5.

The loads indicated are those used in checking the mechanism during the initial investigation.

It will be noted the summation of the moments due to line pull is the same regardless of the location of the ropes on the drum, hence, the reaction at R_2 and R_5 remains the same.

These forces were reduced in the final design, as the line pull on the ropes were reduced from 19,490 to 16,590 lb.

From the final design of the revamped parts of the main hoist, the weight of the main trolley was very carefully calculated.

Table II indicated the final tabulated loads. It will be noted the original assumed hoist load of 370 tons was slightly more than the final estimated load of 365.5 tons.

The calculations, weights and proposed methods of revamping the crane were carefully reviewed with the crane manufacturer. Particular attention was paid to the dead weight of the trolley, wheel, loads and the crane girders. The crane manufacturer concurred in general as to loads, stresses, and methods of revamping.

Because of the critical nature of this particular job, it was decided to have a consulting engineering firm to conduct a separate investigation of the stresses in the crane parts—particularly the structural members.

The results of this investigation was also in close agreement with those of the previous investigations. On their recommendation, a 14¾ x ¾-in. plate was welded to the 175-lb main hoist trolley rail to reduce stress in the rail and help distribute the load in the main bridge girders. Also, as a safety measure, a tattle-tale light was installed to indicate to the operator when one of the main hoist motors had failed.

The results of these investigations indicated that the anticipated stresses in the main bridge girders would approach the maximum allowable stresses of 18,000 psi in tension and 17,000 psi in compression. Therefore, any future increase in loading was out of the question unless extensive strengthening of the crane was carried out.

The building columns, girders, jack trusses and other parts of the crane runway were checked, using the new estimated crane loads. The results of this investigation indicated the building would be satisfactory for the new loading.

Since the calculations indicated the job could be done, the next problem was to determine how the job could most economically and expediently be carried out.

In July, 1951, the original crane manufacturer was asked to offer a quotation and estimate of time required to furnish the necessary new parts, revisions to existing parts, assembly of the revised trolley and hook beam, and their estimate was to be predicated on the existing trolley to be dismantled and sent to their shop.

The crane manufacturer estimated that because of the heavy backlog of work already in their schedule, the necessary engineering work would take approximately 14 months to complete. An additional seven to eight months would be required to complete the fabrication of parts, due to the limitations of securing certain critical materials because of the existing allocation program.

It was estimated that 61 days would be required to dismantle one trolley, ship to crane manufacturer's shop, assemble new parts, return and erect the new trolley.

TABLE II

Tabulation of Main Hoist Trolley Loads on Revamped Basis

	Lb	
Load on ropes:		
Hook beam	46,000	
(2) 175-Ton hooks	34,000	
Ladle and lining	145,000	
Metal load	500,000	
3-in. slag	6,000	
Total load on ropes	731,000	or 365.5 tons
Total weight on 8 trolley wheels:		
Trolley weight	215,000	
Load on ropes	731,000	
	946,000	or 473 tons

During this period, the open hearth department would have to operate with only one crane.

In view of the overall picture as outlined above, it was recommended that this project could best be engineered, planned and executed if carried out by Granite City Steel Co. personnel.

In September, 1951, the necessary approval was given to proceed with the job as recommended.

In order to expedite manufacture and delivery of the new parts, local manufacturing plants were used whenever possible.

As the new parts arrived in the plant, they were stored wherever possible. Most of the plant was in the process of an extensive construction program and storage space was at a premium. In most cases, the parts were stored some distance from the project site. Prior to starting the rebuilding of the first crane, each part was carefully rechecked.

In order to properly carry out a project of this nature, it is important that some definite schedule, or plan of execution, be set up. This was particularly important in this case, because the necessity of keeping the crane downtime to a minimum. If anything should happen to the other crane, it would seriously hamper operation in the open hearth department.

In making up the schedule, it was apparent that very close timing would be required throughout the whole project. The schedule on the first crane was tentatively set for 24 to 27 days, based on 16 hr per day in the field and 16 hr per day in the maintenance shop, whenever possible.

It was planned to do all the necessary dismantlement, alteration to structural members and reassembly of parts right on the crane. In order to secure the maximum safety while working in the air, a substantial working platform was imperative. The necessary platforms were prefabricated out of 6 x 9-in. railroad ties on 24-in. centers and floored with 2-in. lumber. The prefabricated scaffold was made up in nine sections so it could be hoisted up and set in place in a minimum amount of time. This gave a working platform inside the main girders at the auxiliary girder level approximately three-fourths of the length of the crane.

Special wood boxes were made for storage of small parts. Each box was labeled for a specific part of the crane. These proved quite satisfactory for preventing mix-ups or loss of parts.

To facilitate the work on the cranes, there was available a 15-ton repair trolley at each end of the shop. Each repair trolley is on a runway running perpendicular to the pouring aisle at truss level. These repair trolleys are each operated from a stationary platform.

Because of the location of the repair trolleys, it is impossible to park a crane under either one for a long period of time without seriously hampering the other operations in the open hearth. It was therefore necessary to use the trolleys only while hoisting or lowering parts to the bridge. At all other times, the cranes had to be kept in the "hole" while performing the necessary alterations.

A two-way telephone communication system was set up between the bridge and the crane cab. Another two-way telephone system was set up between the repair trolley operator's platform and the bridge. This was essential since the operators stationed at these points could not see or hear instructions directed to them.

Two trucks were used to shuttle parts from the crane to the shop, shop to crane and from the storage areas to both crane and shop. Because of the construction taking place adjacent to the revamping site, there was no place to store parts on the ground. Each part had to be trucked in as required.

On February 23, 1953, the construction crews took the first crane out of operation to begin the rebuilding. The first day was spent cleaning the crane, removing the hooks, bail, cables, disconnecting electrical equipment and installing the prefabricated scaffold.

By the end of the third day, the trolley was stripped of all equipment which was to be replaced or altered, except the trolley wheels, axles and bearing capsules. To expedite their removal and still permit the rigging crews to prepare the trolley for new structural members, cutting and spreading the trolley the required 22½ in.,

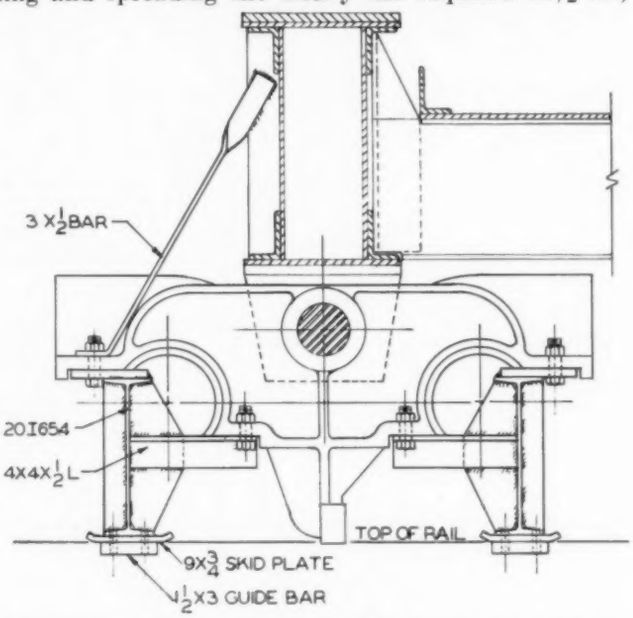


Figure 3 — Trolley support and skid shown were installed in place of the wheels as each one was removed.

installation of the new structural members, the fabrications shown in Figure 3 were made and installed in place of the wheels as each one was removed. These fabrications served three purposes.

1. To maintain the trolley level above trolley rail.
2. To keep the trolley reasonably square while spreading it apart.
3. To act as skids while spreading trolley frame.

The heavier hoist motor side of the trolley was securely anchored to the trolley rails to prevent movement. The lighter trolley drive motor side was left free to move, but blocked to prevent turning. The trolley was cut into with cutting torches and with the aid of two 25-ton hydraulic jacks, one on each side, the trolley frame was jacked apart the required 22½ in.

The trolley frame was carefully levelled and squared before riveting the new structural members in place.

In the meantime, the necessary alterations and reassembly of parts was being carried out in the maintenance shops and outside job shops.

The new trolley wheels were ready for installation by the end of the second week. These were followed by the sheaves, drums, pinion shafts and so forth.

Because the new 250-ton ladles had not yet arrived, the old 135-ton ladle hooks were rebored to fit the new 10-in. diam hook pin in the lifting beam. A spacer was inserted on the outside of each hook to give the correct center-to-center distance for the 210-ton ladles still in use. These hooks were to be replaced at a future date, when sufficient 250-ton ladles were on hand.

The crane was reeved and ready for testing 18 days after the project was started.

An initial load test of 343 tons was put on the newly rebuilt crane before turning it over to the operating people.

The second ladle crane was taken out of service March 23, 1953, ten days after the first crane was returned to the operating personnel. With the experience gained on the first crane, the time required to revamp the second crane was reduced to only eleven days. The crane was load tested on the twelfth day after the project was undertaken.

The second crane was given an initial load test of 335 tons before returning it to the operating department.

The expediency at which these cranes were rebuilt can be attributed to planning, close coordination between field and shop, and to the extra effort put forth by all the personnel involved.

On April 23-25, 1953, after several new 250-ton ladles had been received, each of the cranes were load tested with two 250 ton ladles loaded with pig iron. One ladle was suspended on the hooks, the other ladle was suspended below by 24 parts of 1⅛-in. diam rope lashed around the lift beam and each trunnion. The total weight on the bail and hooks was approximately 422 tons. This represented a 29.8 per cent overload for the new 325-net ton rating.

The load test on each crane consisted of five parts:

a. Two motor hoisting and lowering.
b. One motor hoisting and lowering (north motor).
c. One motor hoisting and lowering (south motor).
d. Rack the load across the bridge.
e. Bridging the crane under load.

Table III indicates the load data gathered on the test.

During the test the cranes were carefully inspected for any visible malfunction or failure. The performance of the cranes during the tests was deemed satisfactory and after a close inspection of the mechanical parts, the cranes were turned over to the operating people for handling 250-ton metal loads.

TABLE III
Motor Data from Load Test of Ladle Crane

Test	Average line voltage, d-c	Average amp	Rpm	Hp
Line voltage before test	242	.....	.....	.....
Two-motor operation:				
(A) North motor hoisting	230	436.5	412	122
(B) South motor hoisting	.....	409	.....	117
(C) North motor lowering	248	342.5	424*	.....
(D) South motor lowering	.....	328	.....	.....
One-motor operation:				
(A) North motor hoisting	234	735	340	185
(B) South motor hoisting	230	756	327	191
(C) North motor lowering	246	533	630*	.....
(D) South motor lowering	244	522	620*	.....

*Indicates regenerative circuit.

Figure 4 — Changing the reeving made it necessary to increase the width of the main hoist trolley 22½ in.

During the past two years the cranes have handled approximately 3,840 heats without incident.

The maintenance cost on these cranes was expected to increase somewhat due to the increased stresses induced in some of the members. The maintenance cost per ton of steel handled for the past two years, has shown no increase to date.

The results obtained by this project can by no means be applicable to all cases. Each case must be considered separately and carefully analyzed for its own particular operational characteristics.

In the case just reviewed, the company was fortunate because the building was sufficient'y strong to accommodate the increased loading without rebuilding; the original cranes had been built with a sufficiently high safety factor in most of the crane parts that it was economically feasible to rebuild these particular cranes to suit Granite City Steel Co.'s own particular requirements.

DISCUSSION

PRESENTED BY

C. F. SIMMERS, Assistant Vice President of Engineering, Morgan Engineering Co., Alliance, Ohio.

R. A. McINTOSH, Special Engineer, Bethlehem Steel Co., Bethlehem, Pa.

EUGENE WHITAKER, Chief Mechanical Engineer, Granite City Steel Co., Granite City, Ill.

H. A. ZOLLINGER, Industry Engineering Department, Westinghouse Electric Corp., East Pittsburgh, Pa.

JOHN L. WOMACK, Design Engineer, Homestead Works, United States Steel Corp., Munhall, Pa.

W. R. GRAY, Test Engineer, Inland Steel Co., East Chicago, Ind.

C. F. Simmers: The ladle crane Mr. Whitaker refers to and Granite City Steel Co. revamped to increase its

capacity from 270 ton to 325 ton, was built by our company.

Fortunately, major parts such as the crane girders, trucks and end ties, wheels, wheel assemblies and so forth, were of sufficient strength not to require replacement; otherwise, a new crane of higher capacity would be required to handle the additional load of 55 tons. We note the open hearth building which supports the ladle crane is of sufficient strength to support the heavier load without being reinforced.

The new wave of mill expansion we are now entering has brought us numerous inquiries regarding the increasing of loads on existing hot metal and ladle cranes.

The number of studies made to determine if the customer's ladle cranes are capable of operating with higher loads than that for which the crane was originally designed, indicate that the ropes, a few mechanical parts, trolley frame, and so forth, will be under the prescribed factor of safety for ladle cranes.

After each study is completed, we make our recommendation and proposal to the customer regarding the changes required to place the crane in a safe operating condition when handling higher live loads.

We are at present engineering the revamping of a 300-ton ladle crane to handle 375 tons, which is an increase in live load of 25 per cent.

In order to keep the revamping to a minimum we are going to increase the parts of rope from 52 to 60 which will impose a load on the mechanical parts, such as gearing, shafting and so forth, about 6 per cent. These mechanical parts are of sufficient strength and will not require replacement when handling the 6 per cent heavier load.

The drums will not be altered, but since the parts of rope will be changed, the lift will be shortened by approximately 4 ft-6 in. The large trolley frame will require reinforcing.

The increased live load will not affect the main bridge girders, as the new calculated combined stress is within the allowable set up by the AISE specifications.

All other major parts check to be satisfactory.

Since the hot metal ladle crane is the easiest working crane of all steel mill cranes because of its slow speed and maximum resiliency due to its many parts of rope, we sometimes wonder if it is not overdesigned, especially on the nonmechanical parts because of the high factor of safety required by the steel industry.

R. A. McIntosh: This description of the analysis and rebuilding of the ladle cranes at Granite City was particularly interesting to us as we have made similar analyses of ladle cranes in two of our plants. One set of these cranes is now operating with the increased load.

Our analysis followed the same pattern as described. However, we were more fortunate in having sufficient capacity in the original design so that we did not have the extensive rebuilding problem that was necessary at Granite City to accommodate the increased ladle load. Specifically, the cranes, which now carry increased loads of the same order as theirs, were originally equipped with 52 parts of 1¼-in. rope so this item of possible overload did not exist in our case.

One question which arose during our study may be worth raising again here. Table I indicates that the strength of the main hoist ropes was based on the ultimate tensile strength and a factor of safety of 8 or 10. Was this (and the AISE standard for minimum sheave diameter of 30 times the rope diameter for 6 x 37 rope) the only criterion used or were checks made of the bending stress or unit radial pressure of the rope in the groove of the sheave or drum?

We feel that the factor of 10 which is normally used on these hoist rope applications is a life factor and can be lowered within reasonable limits if it is recognized that closer inspection and more frequent maintenance will be required.

Wear on the runway rails has increased due to the heavier wheel loads in the shop with the cranes of increased capacity.

Increasing the capacity of these cranes is a good example of what can be done to increase the capacity of existing equipment when it is needed and still stay within the limits of reasonable factors of safety. Obviously, this may not be done arbitrarily, but only after a thorough analysis of the parts, including a check to see that the parts are in good condition and the building satisfactory for the increased load.

Eugene Whitaker: The safety factor of 10 based on ultimate strength of the wire rope was used as a guide in our design and selection of the wire rope but not necessarily a criterion.

We did make some checks of the radial pressure of the rope in the groove of the drums. These pressures were found satisfactory.

We had proposed to use the existing sheaves, which were slightly less than 30 times the new rope diameter. The question as to whether we could expect satisfactory rope service with these sheaves was referred to a rope manufacturer. Their engineering department informed us that we could expect satisfactory life with our 33¾-in. diam sheaves regrooved for 1¼-in. rope. What checks they made relating to bending stresses and radial pressures, I do not know.

H. A. Zollinger: Mr. Whitaker's paper shows definitely the benefits gained by anchored pre-planning and careful supervision during revamping.

I noted with interest the pawl, ratchet, and the worm gear arrangement used on these cranes. This arrangement seems to be a good attempt to gain some of the advantages of a mechanical load brake system normally used with a-c cranes, and not hamper the equipment by some of its disadvantages. It also provides other advantages such as requiring all four brakes to operate when using one motor, will not pay off excessive slack rope, guards against dropping the load with a mechanical failure of a set of mechanical parts, and allows the two motors to share the load without adding any extra stress to the drive shaft.

Load sharing between both 135-hp mill motors during hoisting and lowering is shown to be good. When the revamp was considered, I wonder why the possibility of using 44 parts of 1⅜-in. rope was not considered. With this change the MCSA-16 motors could have been replaced by MCA-616 mill motors, and the same hook speed retained. The MCA-616 motor would provide more than enough extra torque for the increase in load. With this the existing trolley maybe could have remained the same width. I realize this is an after

thought, but quite often on these revamps a change in the electrical equipment can economically eliminate mechanical changes.

Eugene Whitaker: There are several reasons why we did not seriously consider 1⅜-in. diam rope.

First, we would have had to purchase new drums, sheaves, and related parts, as this equipment did not have sufficient material to allow for remachining for the larger rope.

We felt the sacrifice of hook speed by going to 52 parts of 1¼-in. rope was not detrimental enough to outweigh the advantages.

Our studies of the various possible rope combinations indicated the selected reeving had these advantages: better efficiency, lower initial installation cost, lower replacement cost, less dead weight, and a satisfactory factor of safety.

John L. Womack: Like Granite Steel Co. and other steel manufacturers, United States Steel Corp.'s Homestead District works has initiated a program for increasing its open hearth facilities. One of the major projects of this program consisted of increasing the capacity of four 4-girder ladle cranes from 300 tons to 425-ton units. Two of these cranes have already been thus revamped and have been in operation for several months.

In this paper, Mr. Whitaker singled out the main hoist for his discussion, since stresses and safety factors of all other critical ladle crane parts came within the limits set-up in the AISE specifications for EOT cranes.

Homestead's analysis of these increased loads and stresses revealed a picture differing slightly from that presented by Mr. Whitaker's paper. To meet the AISE specifications for EOT cranes, a number of trolley and bridge alterations were also required.

The vital importance of investigating every ladle crane part and all factors complementary to crane operation should be stressed when such work is contemplated.

W. R. Gray: I would like to ask the following questions:

1. Were the bridge wheel loading in excess of AISE recommendations?
2. If the wheels are carburized, were wheel loadings in excess of manufacturer's recommendations?
3. Were crane horsepower requirements based on one-hour motor ratings?

Eugene Whitaker: The bridge wheel loading was calculated to be about 135,700 lb under a maximum loading condition. The AISE recommendations for this particular wheel is 135,000 lb.

The wheels used are carburized wheels and the manufacturers load rating for this wheel is the same as the AISE recommendations.

For normal two-motor operation horsepower requirements were based on 75 C rise in approximately one hr. When on one motor emergency operation, this time decreases to about 12 min.

Our estimated horsepower requirements were checked against the performance curves for these motors furnished us by the manufacturer.

The performance of these motors were later verified when we load tested the crane.

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ASSOCIATION OF IRON AND STEEL ENGINEERS
1010 Empire Building Pittsburgh 22, Pa.

Remote Control of Equipment Over Existing Power Lines

. . . . the use of carrier currents enables one to use all existing wires for many purposes . . . . control cables, telephone lines, power lines, or any metallic circuit can act as a transmission path for carrier signals . . . .

By JOHN W. BAUER, JR.
Sales Engineer
Femco, Inc.
Irwin, Pa.

▲ REMOTE control of equipment over existing power lines is being used extensively by industry today. The ability to use power lines enables management to consider new control functions heretofore rejected because of the high installation costs of multi-conductor cables and collector rails.

Since the end of World War II, carrier current equipment has been developed to where power lines are used as transmission circuits for communication and control and indication systems. Many obstacles such as varying d-c voltages, dust, vibration, etc., have been overcome. The equipment is of a rugged design that also employs an ease of maintenance feature. Plug-in components, swinging racks and plug connected chassis, aid the maintenance man in his work.

Carrier current equipment operates in the frequency band between 20 and 200 kc. By the proper means of inductive or capacitive coupling, carrier current signal can be superimposed on power lines of any voltage. Frequency modulation and squelch circuits eliminate the noise that is on power lines so that carrier current signals are free of interference. The design of RF filtering permits the use of many frequencies operating on the same line at the same time. Carrier equipment operates directly from either a-c or d-c power. Variations of the power source are not critical to this equipment. Standard tubes and component parts are used in the design of carrier equipment.

The basic part of control or indication system is the carrier transmitter and carrier receiver. Keying the transmitter on or off or transmitting signal or no signal will operate a relay at the output of the receiver. This is a simple single channel control or indication system.

Two-channel operation is obtained by shifting the mean frequency of the transmitter up and down. In this system, two separate relays are operated at the receiver. Two controls or two indications are thus available. This unit may be used for circuit breaker control and indication or controlling forward and reverse of a motor. The carrier shift transmitter and receiver is also the basic part of multiple control and indication systems.

When multi-channel systems are necessary, you can, of course, use different RF frequencies for each operation. We prefer to use either tone or relay modulation of one carrier frequency to obtain multiple systems.

Figure 1 — The trolley phone is quite compact.

For example, each audio tone that is modulated on a carrier provides a separate control channel. If audio tones are used in sequence operations, many controls and indication channels are available. Supervisory control systems for substations and circuit breakers are designed using tone-modulated carrier. With a central office unit, remote controls are provided at a single or many remote locations. The control of motors and many other applications are also available with this equipment.

Relay modulated carrier is used when simultaneous control is not required. Although in many systems the speed of the relays is so fast that it appears as simultaneous to the equipment being controlled.

Relays and carrier shift transmitters and receivers are used in different types of systems. One type is where you have multiple selection of many operations and a common control channel. The use of a stepping switch permits as many as 50 different functions to be selected. After selection is made, a two-channel control is provided for operating a motor. This type of equipment is used to control the opening and closing of soaking pit covers from the overhead crane. It is also used to control ingot buggies from overhead cranes. The crane operator first selects which cover he wants to open. A three position master then controls the opening, closing and stopping of the cover. Selection is retained until the craneman wants to move to a new location. Positioning and operating the ingot buggy is done in the same manner. Anything on the floor, such as motors, furnace doors in open hearths, conveyors, etc., are controlled from overhead cranes.

Another relay with carrier shift transmitter and receiver system is available to control overhead cranes from the floor. Here the relay transmitter consists of a counting chain of relays. For example, 35 circuits are made between floor and crane in $\frac{1}{3}$ of a second. To the electric control boards this appears as a simultaneous operation. As you can see, it is thus possible to provide all the required speed control points for hoists, bridge, trolley and magnet controls. Any crane may be operated remotely by this type of system.

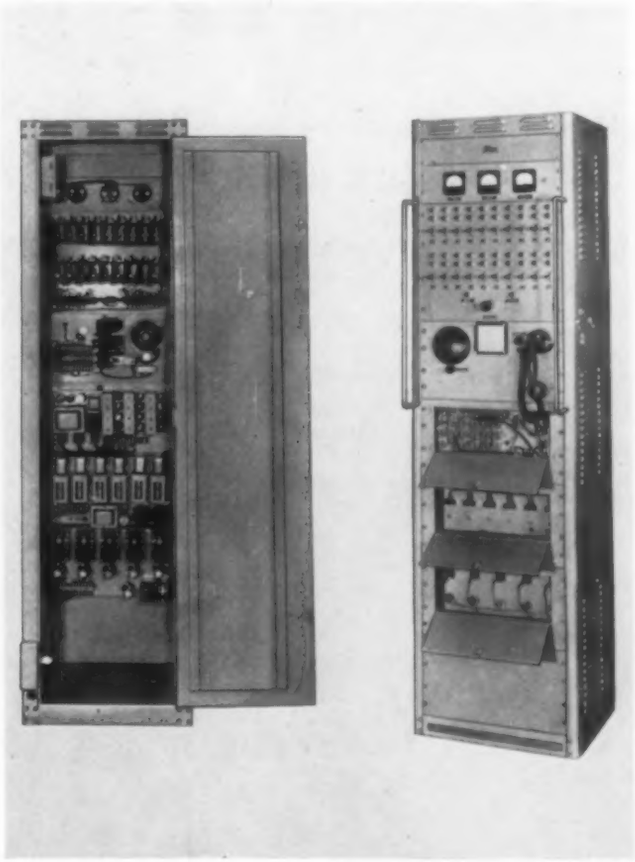
The following will give some specific examples of installations using the equipment, and will point out what the systems consist of, why they were purchased together with a brief description of the operation procedure.

SINGLE CHANNEL SIGNAL SYSTEM

The simple single channel signal system was installed as a safety warning system. Men were cleaning out the bottoms of ore cars and they were in extreme danger when the railroad locomotive was preparing to haul away the cars. A signal, that could be initiated by the railroad personnel, was required to warn plant personnel. The cost of installing wire in conduit, which had to be buried along the tracks, was prohibitive, so a carrier transmitter and push button were installed at the border of the plant property. The unit was powered from a 250-v, d-c lighting circuit and the RF signal was superimposed on the same 250-v, d-c line. This power line was connected to the main mill supply and carried the RF signal to the area of the sinter plant. At this

Figure 2 — Supervisory control system shown has a central control panel and six remote station units.

Figure 3 — Rear and front of bit carrier control and indication system's central control panel are shown.



location the receiver, signal light, and warning siren were installed. When the railroad personnel operated the transmitter push button, the warning siren sounded and thus, all plant personnel in danger were alerted. No wires were required except the 250-v, d-c power system.

Another installation of the single channel system provided both a control and indication signal. It was found to be very desirable and essential for the operator of the quench car in a coke plant to be able to signal the pusher operator and also to control the forward motion of the ram. A carrier transmitter and footswitch were installed on the quench car. The RF signal was transmitted over the 250-v, d-c power rails to the pusher on the other side of the ovens. At the receiver on the pusher, two relays were operated. One relay operated a signal light which indicated that it was time for a push. The other relay controlled and interlocked the forward speed circuit of the ram. Thus, it was possible to provide both a control and indication signal using a simple single channel system. No additional collector rails were required for this installation.

AUDIO CARRIER — DRAG BUCKET CONTROL

A multi-channel control was installed to provide a system that simultaneously controlled three motors on a drag bucket in a power plant. The operator controlling the coal handling operation was located on one side of the coal pile, while the motors for the bucket were on the opposite side. The cost of installing a collector system for this control was prohibitive. A carrier transmitter modulated with three audio tones and control switches were installed at the control pulpit. The RF signal was transmitted over the a-c power system to the motors. At the motor location, the carrier receiver, audio filters and control relays were installed and connected to the motor control circuits. The multi-channel system then provided the operator with simultaneous or separate on-off control of the three motors. As an added feature, two way voice communication was included in this system. All controls and communication installed for this system operate directly over the a-c power line.

Figure 4 — Soaking pit cover controls are an important steel plant application.

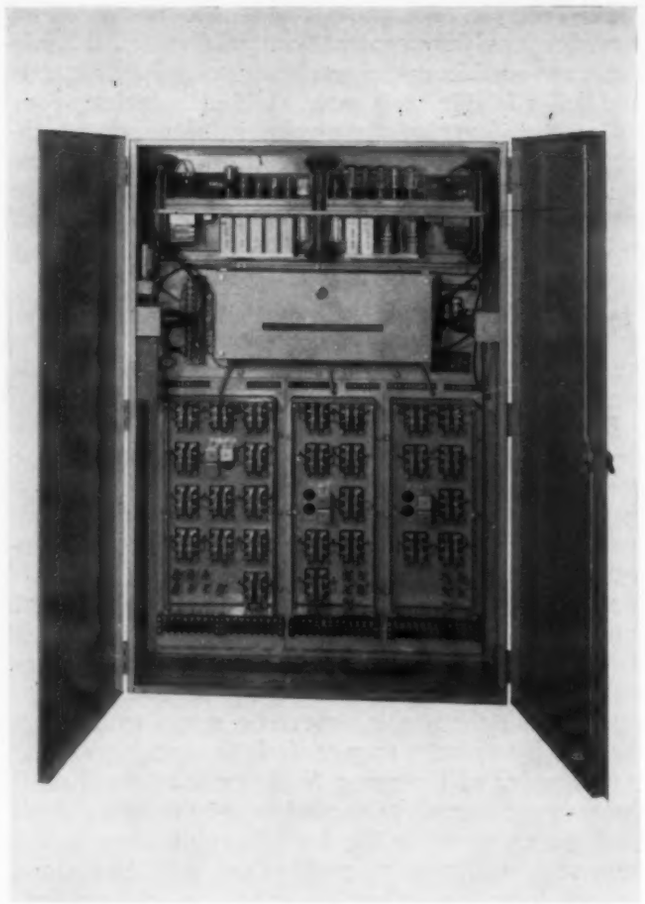


Figure 5 — Remote crane control panel is mounted in crane.

AUDIO CARRIER — SUPERVISORY CONTROL SYSTEM

Another tone modulated carrier system is used to provide a supervisory control system for substation and circuit breaker control and indication. Two carrier frequencies are used for two way operation. Six audio tone frequencies in sequence provide 20 control channels. In this system, one central unit controls many remote field units. The operation of the system permits selecting a breaker location, checking the position, and then operating the breaker. A red and green indicating light, and selector switch are mounted on the front of the office unit for each of the twenty breakers to be controlled. One master operate button is used for all operations. Two way communication between the office unit and all field stations is included in this system. The transmission circuit used in this installation was a telephone circuit. No interference between telephone or control circuits was encountered.

RELAY CARRIER — SOAKING PIT CONTROL SYSTEM

A multiple selection, common control relay modulated carrier system was designed to permit opening of soaking pit covers from an overhead crane. The over-

head crane operator can select any one of 50 covers. One cover at a time is then opened or closed by use of a master switch. The equipment mounted in the crane consists of a carrier transmitter, selector unit and master control switch. RF signals are superimposed on the 250-v, d-c power rails. The ground unit consists of a carrier receiver, selector unit and operating relays which are wired to the electric control panels that control the covers. If more than one overhead crane is involved, a separate frequency is used for each crane. All cranes then have control of all the covers and can operate simultaneously. The only connection between the crane units and the floor station is the 250-v, d-c power rails. No collector rails are required for control circuits.

Another system of the same type is used to position and operate an ingot buggy from the overhead crane. The same units are involved as in the soaking pit control system. The crane operator selects the position at which the buggy is to stop. The master control switch then provides for forward or reverse of the ingot buggy motor. The ingot buggy control system also operates by transmitting RF signals over the 250-v, d-c power system and no control rails are required.

RELAY CARRIER — REMOTE CRANE CONTROL SYSTEM

A relay carrier system for controlling cranes must operate almost simultaneously to provide for speed control points for hoist, bridge, trolley and magnet. The operating speed of this system is $\frac{1}{3}$ second and it appears to be simultaneous to the standard electric control boards. The equipment on the floor console consists of the standard control masters for hoist, bridge, trolley and magnet together with a relay transmitter and carrier transmitter. The crane equipment is one unit consisting of the carrier receiver, relay receiver and operating relay panels for hoist, bridge, trolley and magnet. This unit is wired to standard electric control boards. One carrier frequency is used with a relay counting chain to provide 50 coded circuits for use between floor and crane. The RF signals are transmitted over the 250-v, d-c power rails without any added collector rails. All standard features of operation such as inching and plugging are retained. This system is compatible with all standard electric control boards.

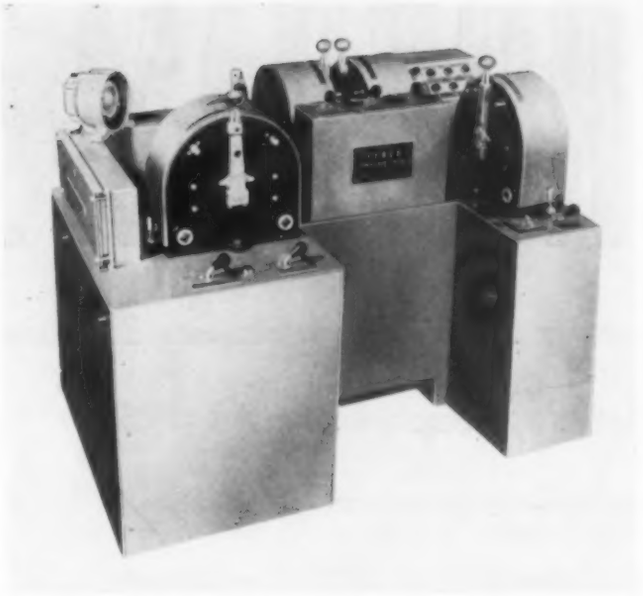


Figure 6 — Floor control console for remote crane control.

To stress one point in particular, carrier current enables one to use *all* existing wires for many purposes. Power lines, control wires, telephone lines, or any metallic circuit will act as a transmission path for carrier signals.

The development of carrier current as it applies to remote control systems has been designed and proven in the field. The extent to which carrier current can be used rests with the personnel of industry. A study of some of the problems will show that carrier current systems are the answer to many of them.

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PROGRAM

1956 AISE CONVENTION and IRON AND STEEL EXPOSITION

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CLEVELAND PUBLIC AUDITORIUM
CLEVELAND, OHIO

Tuesday, September 25, 1956

9:00 am — REGISTRATION — Main Lobby

9:15 am — BUSINESS MEETING — Ballroom

Conducted by President W. H. Collison

9:30 am — ELECTRICAL SESSION — Ballroom

Chairmen: Ray T. Winterringer, Assistant Superintendent Electrical Department, South Chicago Works, Republic Steel Corp., Chicago, Ill.

Richard G. Nolan, Electrical Engineer, Granite City Steel Co., Granite City, Ill.

"Electrical Equipment for Continuous Annealing of Silicon Steel Strip," by G. J. Hay, Steel Mill Engineer, Westinghouse Electric Corp., East Pittsburgh, Pa., and Hugh S. Fegely, Control Design Engineer, Westinghouse Electric Corp., Buffalo, N. Y.

"Application of Speed Controls for Hot Strip Finishing Mills," by George S. Koss, Superintendent Plate, Slab and Strip Mill and Louis E. Ringger, General Supervisor, Electrical Engineering, Columbia-Geneva Steel Division, United States Steel Corp., Provo, Utah.

"Electrical Features of a Hot Strip Mill Reversing Rougher with Close Coupled Edger," by J. H. Greiner, Application Engineer, Electrical Application Department, and A. Mozina, Engineer, Control Section, Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

9:30 am — BLAST FURNACE SESSION — Club Room B

Chairmen: J. H. Strassburger, Assistant Vice President, National Steel Corp., Pittsburgh, Pa.

George H. Greene, Assistant General Manager, Bethlehem Steel Co., Johnstown, Pa.

"Reducing Delays During the Blast Furnace Campaign Through Improvement of Mechanical Features," by W. O. Bishop, Superintendent, and Charles P. Frame, Mechanical Foreman, Plant 2 Blast Furnaces, Inland Steel Co., East Chicago, Ind.

"Automatic Split-Wind Blowing Equipment—Duquesne Works," by James S. Frazer, Jr., General Supervisor-Power and Fuel, Engineering Department, Duquesne Works, United States Steel Corp., Duquesne, Pa.

"Development of Tuyere Air Proportioning for the Blast Furnace," by E. K. Miller, Jr., Assistant Division Superintendent, Blast Furnaces, Gary Steel Works, United States Steel Corp., Gary, Ind.

2:00 pm — MECHANICAL SESSION — Club Room B

Chairmen: C. W. Bruce, Chief Engineer, Chicago District, Republic Steel Corp., Chicago, Ill.

Charles H. Good, Jr., Chief Engineer, Duquesne Works, United States Steel Corp., Duquesne, Pa.

"The Design of Mill Buildings," by J. J. Murray, Development Engineer, Jones & Laughlin Steel Corp., Pittsburgh, Pa., and Thomas C. Graham, Chief Design Draftsman, Design Engineering Department, Pittsburgh Works, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

"Treatment and Re-use of Mill Scale Wastes to Conserve Water and Abate Pollution," by Grant A. Pettit, Industrial Waste Control Engineer, Armco Steel Corp., Middletown, Ohio.

"Economics of Oxygen Generating Stations for Steel Mill High and Low Purity Oxygen Applications," by Arthur E. Steele, Manager, and Donald E. Cummings, Assistant Manager, Steel Mill Sales Division, Air Products, Inc., Allentown, Pa.

2:00 pm — COMBUSTION SESSION — Ballroom

Chairmen: R. A. Lambert, Superintendent Steam & Combustion, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

David Cousley, Assistant Superintendent Utilities, Wheeling Steel Corp., Steubenville, Ohio.

"The Relative Value of Various Gases for Scarfing," by W. M. Bloom, Combustion Engineer, Allegheny Ludlum Steel Corp., Brackenridge, Pa.

"The Prevention of Gas Incidents," by T. A. Watson, Assistant Division Superintendent, Power Production, United States Steel Corp., South Works, Chicago, Ill.

"Control of Atmosphere Generators," by R. R. Swain, Manager Iron and Steel Division, Bailey Meter Co., Cleveland, Ohio.

Wednesday, September 26, 1956

9:00 am — ELECTRICAL SESSION — Ballroom

Chairmen: F. H. Wickline, Electrical Engineer, United States Steel Corp., National Tube Division, Pittsburgh, Pa.

Ernest F. Donatic, Assistant General Superintendent, Service Division, Kaiser Steel Co., Fontana, Calif.

"Greater Flexibility for Wire Drawing," by R. C. Suttle, Application Engineer, Reliance Electric & Engineering Co., Cleveland, Ohio, and Maurice A. Nye, Chief Engineer, The Vaughn Machinery Co., Cuyahoga Falls, Ohio.

"Electrical Maintenance at the Pueblo Plant of the Colorado Fuel & Iron Corp.," by H. E. Watson, Electrical Superintendent, The Colorado Fuel & Iron Corp., Pueblo, Colo.

"Protection of Men Exposed to the Hazards of Moving Overhead Electric Cranes," by Harold R. Miller, General Foreman Assigned Maintenance, Butler Works, Armco Steel Corp., Butler, Pa.

9:00 am — COMBUSTION SESSION — Club Room B

Chairmen: Frank C. McGough, Superintendent Power & Fuel, Detroit Steel Corp., Portsmouth Works, Portsmouth, Ohio

H. B. Helm, Fuel Engineer, Youngstown Sheet & Tube Co., East Chicago, Ind.

Exposition and Technical Sessions are at Cleveland Public Auditorium . . .

"Normalizing and Heat Treating of Steel Plate," by Horace Drever, President, and N. K. Willis, Chief Engineer, Drever Co., Bethayres, Pa.

"Study of Factors Influencing Surface Staining of Cold Rolled Steel,"

Part I — "Types of Defects and Their Occurrence," by C. R. Lillie, Research Metallurgist and D. W. Levinson, Supervisor, Non-ferrous Metals Research, Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill.

Part II — "Identification and Reaction Mechanisms," by F. Schossberger, Senior Scientist, K. Hattori, Research Chemist, and H. Marver, Assistant Chemist, Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill.

"Modernization of Wheel Heating Facilities, Johnstown Plant, Bethlehem Steel Co.," by F. R. Pullen, Fuel Engineer, Bethlehem Steel Co., Johnstown, Pa.

2:00 pm — OPERATING PRACTICE SESSION — Ballroom

Chairmen: Karl L. Fetters, Assistant Vice President, Youngstown Sheet and Tube Co., Youngstown, Ohio.

S. O. Evans, Manager Tubing Operations, Babcock & Wilcox Co., Tubular Products Division, Beaver Falls, Pa.

"Nuclear Technology and the Steel Industry," by R. P. Peterson, Director Nuclear Research, Republic Steel Corp., Cleveland, Ohio.

"Transportation Control in Steelmaking," by J. L. Kerins, General Transportation Manager, Steel Operating Division, United States Steel Corp., Pittsburgh, Pa.

"Pipe: Manufacture and Use," by P. D. Thomas, Materials Engineer, Asiatic Petroleum Corp., New York, N. Y.

2:00 pm — LUBRICATION AND PAINT SESSION — Club Room B

Chairmen: Donald E. Whitehead, General Lubrication Engineer, Crucible Steel Co. of America, Pittsburgh, Pa.

Charles T. Lewis, Chief Lubrication Engineer, Republic Steel Corp., Cleveland, Ohio.

"Solvent Degreasing — A Valuable Industrial Cleaning Process," by W. L. McCracken, Director of Research, Detrex Corp., Detroit, Mich.

"Evaluation and Specification of Paint for Industrial Use," by Joseph Bigos, Senior Fellow, Mellon Institute, and Director of Research, Steel Structures Painting Council, Pittsburgh, Pa.

"Silicone Lubricants and Protective Coatings in the Steel Industry,"

Part I — "Silicone Lubricants," by W. H. Ragborg, Laboratory Supervisor, and W. H. Badger, Development Engineer, Fluids Section, Product Development Laboratories, Dow Corning Corp., Midland, Mich.

Part II — "Silicone Protective Coatings," by R. C. Hedlund, Supervisor, Coatings Laboratory, Product Development Laboratories, Dow Corning Corp., Midland, Mich.

6:30 pm — OLD TIMERS' DINNER

Thursday, September 27, 1956

9:00 am — OPERATING PRACTICE SESSION — Ballroom

Chairmen: George I. Bottcher, Chief Engineer, Allegheny Ludlum Steel Corp., Brackenridge, Pa.

Warren E. Hart, Superintendent Electric Furnace Building, Ford Motor Co., Rouge Plant, Dearborn, Mich.

"Experimental Results with Hollow Electrodes in Electric Steel Furnaces," by W. E. Schwabe, Product and Process Development Laboratory, National Carbon Co., Niagara Falls, N. Y.

"Economic Future of the Large Top Charge Electric Furnace," by Wm. B. Wallis, President, Lectromelt Furnace Co., A McGraw Electric Co. Division, Pittsburgh, Pa.

"Basic Hot Blast Cupola as Source of Hot Metal for Steel Plants," by E. S. Harman, President, E. S. Harman Corp., Chicago, Ill. and Siegfred Tunder, Technical Director, Gesellschaft fur Huttenwerksanlagen, Dusseldorf, Germany.

9:00 am — LUBRICATION SESSION — Club Room B

Chairmen: C. A. Bailey, Lubrication Engineer, United States Steel Co., National Tube Division, Pittsburgh, Pa.

Andrew Cichelli, Lubrication Engineer, Bethlehem Steel Corp., Construction & Engineering Department, Bethlehem, Pa.

"Measurements for the Consistency of Lubricating Greases," by Ben Holliday, Chemist, Materials Engineering Division, Crucible Steel Co., Midland, Pa.

"High Temperature Steel-Mill Greases," by John Simon, Lubrication Engineer, National Works, National Tube Division, United States Steel Corp., McKeesport, Pa.

"Stopping Corrosion by the Use of Rust Preventive Compounds," by R. P. Mills, Manager, Rust Preventive Division, Valvoline Oil Co., Division Ashland Oil and Refining Co., Freedom, Pa.

7:00 pm — FORMAL DINNER AND DANCE — Ballroom

Norman Lewis will give a humorous talk called "The Kick in Life."

Friday, September 28, 1956

9:00 am — ROLLING MILL SESSION — Ballroom

Chairmen: C. S. Lambert, Superintendent, Merchant Mills, Campbell Works Youngstown Sheet and Tube Co., Youngstown, Ohio.

Don C. Horsman, Plant Superintendent, Continental Steel Corp., Kokomo, Ind.

"Seamless Tube Making by the Calmes Process," by Dr. Albert Calmes, Albert Calmes & Co., Milan, Italy, and Clyde Roberts, Chief Engineer, Phoenix Iron and Steel Co., Phoenixville, Pa.

"Backup Rolls and Their Contribution to Gage Variation," by Earl G. Lindsey, General Foreman-Roll Shop, Cold Reduction Department, Sheet and Tin Mill, Columbia-Geneva Steel Division, United States Steel Corp., Pittsburg, Calif.

"Weirton Modernizes Its Hot Mill," by L. A. Fugassi, Assistant Chief Engineer, Weirton Steel Co., Weirton, W. Va.

9:00 am — COMBUSTION SESSION — Club Room B

Chairmen: F. Bruce Bevelheimer, Power & Fuel Engineer, Ford Motor Co., Steel Division, Rouge Plant, Dearborn, Mich.

George H. Krapf, Division Superintendent, Power Production, United States Steel Corp., South Works, Chicago, Ill.

"An Automatic System of Fuel Control," by D. R. Mathews, Open Hearth Superintendent, Alan Wood Steel Co., Conshohocken, Pa.

"Modifications to the Fontana Open Hearth Precipitators," by E. V. Akerlow, Assistant Division Manager, Kaiser Engineers, Steel Division, Oakland, Calif.

"The All-Basic Open Hearth Furnace," by R. P. Heuer, Vice President, and M. A. Fay, Assistant General Sales Manager, General Refractories Co., Philadelphia, Pa.

..... Social Functions are at Hotel Statler

2:00 pm — ELECTRICAL SESSION — Ballroom

Chairmen: Robert T. Lucas, Electrical Superintendent, Weirton Steel Co., Weirton, W. Va.

Clayton L. Squier, Assistant Superintendent, Electrical Department, Bethlehem Steel Co., Lackawanna, N. Y.

"Roughing Motor Inching Drives," by Dr. Roger Shields, Development Engineering Department, Elliott Co., Jeannette, Pa. and H. Kermit Fish, Assistant Electrical Superintendent, Weirton Steel Co., Weirton, W. Va.

"Automatic Gage Control for Cold Reduction Mills," by R. A. Phillips, Analytical Engineering Section, and H. S. Maxwell, Steel Mills Systems Application Engineering Section, General Electric Co., Schenectady, N. Y.

"Automatic Gage Control and Production Analysis on a 'Z' Mill," by J. W. Hopper, Jr., Gage Application Engineer, Pratt & Whitney Co., West Hartford, Conn.

2:00 pm — OPERATING PRACTICE SESSION — Club Room B

Chairmen: H. R. Knust, Assistant to General Manager, Bethlehem Steel Co., Sparrows Point, Md.

H. A. Long, Chief Engineer, Pittsburgh Steel Co., Monessen, Pa.

"Basic Data on Mechanical Cleaning Operations in Steel Plants," by Gilbert D. Dill, Engineer in charge of Steel Division, Wheelabrator Corp., Mishawaka, Ind.

"Automation and its Tooling and the Concept used at Inland Steel Co.'s New Rail Joint Line," by C. E. Chapman, Superintendent, Rail Accessories Department, Inland Steel Co., Indiana Harbor Works, East Chicago, Ind.

"Edge Position Control for the Steel Strip Industry," by Frank J Markey, Manager, Edge Position Controls Division, Askania Regulator Co., Chicago, Ill.

IRON AND STEEL EXPOSITION HOURS

SEPTEMBER 25—TUESDAY . . . . . 10:00 A.M. TO 10:00 P.M.
SEPTEMBER 26—WEDNESDAY . . . . . 10:00 A.M. TO 10:00 P.M.
SEPTEMBER 27—THURSDAY . . . . . 10:00 A.M. TO 5:00 P.M.
SEPTEMBER 28—FRIDAY . . . . . 10:00 A.M. TO 4:00 P.M.

IRON AND STEEL EXPOSITION

1956 IRON AND STEEL EXPOSITION

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E

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Foote Bros. Gear and Machine Corp.
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G

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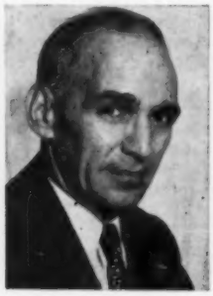

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ABSTRACTS of TECHNICAL PAPERS

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"ELECTRICAL EQUIPMENT FOR CONTINUOUS ANNEALING OF SILICON STEEL STRIP"

by G. J. HAY, Steel Mill Engineer, Westinghouse Electric Corp., East Pittsburgh, Pa., and HUGH S. FEGELY, Control Design Engineer, Westinghouse Electric Corp., Buffalo, N. Y.

G. J. HAY

▲ BECAUSE of its desirable magnetic properties, silicon steel is utilized extensively in the manufacture of electrical equipment. However, a hard and brittle physical property results in a steel which is difficult for both the steel producers and users to handle. In order to improve the physical and magnetic properties, the strip is subjected to a continuous annealing process.

The electrical equipment described here consists of the coil handling drives of the entry and delivery sections, and the tension and speed establishing drives of the annealing section.

HUGH S. FEGELY

The electrical drive systems which move the strip through the line, include precise speed, voltage and tension control. In the entry section, regulated strip tension is maintained as the strip is subjected to an electrolytic cleaning to prevent strip staining or discoloring during subsequent processing. Strip storage for use during entry section stoppages is provided by three deep free-hanging regulated loops; thereby permitting constant annealing section speeds.

In the annealing section, the metallurgical characteristics of the strip are determined. Two of the quantities which aid in this determination are speed and tension. Of these two, speed receives particular attention from the standpoint of regulator design. In addition to aiding in the determination of product characteristics, tension also is important in that excessive tension may cause a costly and time consuming strip breakage in the furnace.

Following the annealing section, two free-hanging loops provide strip storage during delivery section coil removals. A tension regulating system similar to that employed in the entry section is utilized during the recoiling operation in the delivery section.

The entry and delivery section control systems are arranged for both independent and coordinated operation with the annealing section control system. Independent operation is required during coil additions or removals. In order to synchronize the entire line during normal running, coordinated operation is utilized. Special control design consideration is given to the multiple loop regulating systems in order to fully utilize the storage capacities of the entry and delivery looping pits.

Except for loop control, the line regulating systems utilize self-saturating magnetic amplifiers. This design incorporates minimum regulator system maintenance and close control of regulated quantities resulting in high production of consistently good product quality.

"ELECTRICAL FEATURES OF A HOT STRIP MILL REVERSING ROUGHER WITH CLOSE COUPLED EDGER"

by J. H. GREINER, Application Engineer, Electrical Application Department, and A. MOZINA, Engineer, Control Section, Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

▲ THE finishing train of the 90-in. hot strip mill at the Granite City Steel Co. is preceded by a universal roughing mill, the electrical features of which are unique in the manner in which speed matching is ob-

tained between horizontal and vertical rolls for a reduction range of 10 to 55 per cent.

J. H. GREINER

The mill motors and generators were originally specified for a conventional close-coupled drive with a reduction range of 10 to 25 per cent and all motors were to be supported from a common bus.

To accommodate the original machines in a precise speed matching scheme, preset motor fields on both the main mill and edger, with speed matching obtained through edger droop control and reduced edger generator voltage control was used.

Automatic preset screwdown control is used on both the main mill and edger. The main mill preset screwdown control is used to permit preselection of the edger voltage most compatible with the main mill draft to be taken on a particular pass.

A. MOZINA

Using preset edger motor field with edger generator voltage control proportional to main mill draft, the addition of a separate edger droop control obtains a precise speed match without danger of serious edger overload over entire operating range. A further advantage gained from a preset motor field type of operation is reduction in reversal time at all foot master positions since low motor fields do not have to be changed.

"REDUCING DELAYS DURING THE BLAST FURNACE CAMPAIGN THROUGH IMPROVEMENT OF MECHANICAL FEATURES"

by W. O. BISHOP, Superintendent and CHARLES P. FRAME, Mechanical Foreman, Plant 2 Blast Furnaces, Inland Steel Co., East Chicago, Ind.

▲ AS campaign life of the blast furnace has been extended through improvements in lining materials, it has become increasingly apparent that various mechanical features which formerly were satisfactory are now having to be renewed or replaced.

W. O. BISHOP

An effort has been made to bring together in one paper these items such as skip bridge rails, skip sheave wheels, bleeder valves, receiving hopper wearing plates, small bell, seat, large bell, downcomer, bosh plate nipples, and bell cables which have been a source of maintenance or delay at Inland Steel Co. and which have been improved.

In some cases the improvements have lasted the life of the campaign, and in others replacement time or frequency of replacement has been reduced. The solution for some items which fail has not yet been satisfactorily achieved.

CHARLES P. FRAME

Undoubtedly other companies will be able to add to the list or will have made other changes. However, it is believed our comments cover the major items and will be of interest to the industry.

"AUTOMATIC SPLIT-WIND BLOWING EQUIPMENT — DUQUESNE WORKS"

by JAMES S. FRAZER, JR., General Supervisor — Power and Fuel, Engineering Department, Duquesne Works, United States Steel Corp., Duquesne, Pa.

▲ THE latest step in the blast furnace blower replacement program at this U. S. Steel plant was the installation of a 125,000-cfm turboblower with automatic split-wind control equipment. This equipment enables the new blower to serve any two of three furnaces. The control equipment is pneumatic throughout, and is made up of proven components arranged to maintain set point air flows to each furnace and at the same time hold blower discharge pressure at the lowest level to satisfy the blast pressure required at each furnace.

JAMES S. FRAZER, JR.

The air flow to each furnace is measured by an orifice plate and is corrected to standard conditions by automatic compensation for temperature and pressure. Air flows to the furnaces are regulated by 42-in. butterfly control valves which are positioned by pneumatic cylinders receiving signals from flow controllers. These controllers compare the air demand signals as established by panel mounted blowing set points to actual air flows transmitted by air flow recorders. Any unbalance between these two signals causes the output signal from the flow controller to change in the proper direction to restore balance by positioning the butterfly control valve.

By means of automatic selection, the control selects the furnace requiring the highest blast pressure and holds the butterfly control valve for that furnace in the wide open position. Air flow to this furnace is then controlled by varying blower speed while air flow to the other furnace is controlled by throttling its butterfly control valve. This method of split-wind control results in blower discharge pressure being held to a minimum.

The split-wind control panel provides the blowing room operator with all meters, indicators and controls for each of the three furnaces. Blowing rates are easily changed at the request of the blast furnace department by merely changing the blowing set point. Checking the

furnaces for casts, etc., is accomplished by separate controls thus eliminating the necessity of changing the blowing set points.

Operating performance of the split-wind control system has proven reliable, accurate and economical.

"DEVELOPMENT OF TUYERE AIR PROPORTIONING FOR THE BLAST FURNACE"

by E. K. MILLER, JR., Assistant Division Superintendent, Blast Furnaces, Gary Steel Works, United States Steel Corp., Gary, Ind.

E. K. MILLER, JR.

▲ PROPORTIONING the air blast to the tuyeres of a blast furnace is not a new idea, but has been made possible by today's control techniques and materials. Air proportioning is based on the premise that uniform blast to the tuyeres of a blast furnace is an important factor in attaining optimum operation as in uniform raw material sizing, analyses, distribution, etc. Preliminary testing confirmed that the typical blast furnace does not receive its wind in a uniform manner from its tuyeres.

In an effort to achieve uniformity of blast, a proportioning system was installed on Gary No. 1 blast furnace and experiments carried out thereon. As a result of these experiments, it was found necessary to modify the equipment. Subsequently three additional furnaces were equipped with apparatus which differs from the original equipment.

It has been proven that air proportioning is practical in all respects. Like any new development, problems presented themselves and had to be solved. Desirable refinements were developed and installed in the field where necessary.

When the first system was installed, tangible benefits in initial operating performance were not contemplated. It was anticipated, however, that uniform blast would result in more uniform gas and stock flow. It was believed that this, in turn, would result in uniform wear on the furnace lining. Further deductions were: (1) that lining life would be substantially increased, (2) that wear on the lining walls would result in the maintenance of good working furnace lines throughout the major portion of the campaign, (3) that the net result would be the ability to maintain normal high production rates, low coke rate, and high yield.

At present, all furnaces with air proportioning are still in operation, which classes this presentation as a progress report. No. 1 furnace, the oldest, is operating on an extended campaign. To date, the anticipated benefits are being realized as indicated by lack of one-sided operation, more uniform gas flow as judged by stack thermocouples, and quicker return to normalcy after an upset.

In summary, air proportioning is a practical way to achieve uniform blast flow to blast furnace tuyeres. Justification should be attained by long term benefits of longer lining life without substantial deterioration of practice, plus the intangible gains of more uniform furnace operation.

"THE DESIGN OF MILL BUILDINGS"

by J. J. MURRAY, Development Engineer, Jones & Laughlin Steel Corp., Pittsburgh, Pa. and THOMAS C. GRAHAM, Chief Design Draftsman, Design Engineering Department, Pittsburgh Works, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

J. J. MURRAY

▲ THE technical literature reveals very few papers devoted to the subject of mill building design, and this neglect has resulted in wide variations in design procedures and extensive use of empirical or arbitrary "short-cuts." Design specifications vary widely among companies and consulting engineers, and there is a widespread lack of unanimity on the basic questions of loading, structural action under load, and allowable stresses. As a consequence, expensive and important structures are still designed in many instances by "rule-of-thumb" procedures which fail to balance safety and economy to the extent that such an investment warrants. It should be apparent that the design of such structures is a matter of considerable significance, and the use of the most advanced tools of analysis and instrumentation is certainly indicated.

THOMAS C. GRAHAM

The wide variation in opinion on this subject is first emphasized by the differing loading requirements. The wind load, dead load, and crane wheel loads may be readily determined, but the percentages used for impact, side thrust, and longitudinal forces vary with the specification author. The only available test results which might verify or refute any of these assumptions are the series of crane girder tests sponsored by the AISE in 1941. These tests seemed to indicate that vertical impacts on slow-moving cranes were not a major consideration where the runway rails were adequately maintained. There have been no field measurements of the side thrust effect as far as the authors can determine. The longitudinal forces can be estimated with some precision provided the runway bumper is of either the spring or draft gear type.

A primary element of design is the runway crane girder. A trial section must be assumed and then investigated after the moments and shears for the span have been determined in the conventional manner. Runway clearance, deflection, headroom, and lateral and torsional stability must all be considered to produce an economical and workable design.

The second principal structural member is the crane runway column and here the mathematics and assump-

tions of structural action are supported by electric strain gage investigations on full size columns. This procedure and the justification for it are developed in some detail.

Miscellaneous parts of the structure which are discussed included bracing, crane bumpers, crane rails, and purlins. Although not part of the structural design analysis, the lighting, ventilation, and "skin" of the mill building are also reviewed in the light of present day practice. Detailed mathematical examples of the design of a crane girder and a crane column are appended to the paper for those desiring to make a study of the method.

"TREATMENT AND RE-USE OF MILL SCALE WASTES TO CONSERVE WATER AND ABATE POLLUTION"

by GRANT A. PETTIT, Industrial Waste Control Engineer, Armco Steel Corp., Middletown, Ohio.

GRANT A. PETTIT

▲ ARMCO Steel Corp., at its Middletown plant, Middletown, Ohio, recently completed the final step of its program in the treatment of mill scale wastes from the continuous strip mill to conserve water and abate pollution of the Miami River. This program was carried out in two steps over several years. The first step was the installation of a sedimentation basin in 1952, with mechanical collection for the removal of scale and oil from the bar mill wastes only.

This sedimentation basin is made up of three parallel chambers, each chamber 10 ft x 67 ft-10 in. (effective) x 8 ft-6 in. water depth, based on a design flow of 3500 gpm. This basin proved to be a very efficient installation for the removal of mill scales, oil, and grease from the bar mill wastes. The effluent discharged to the sewer from this installation averaged consistently between 40 to 60 ppm, suspended solids and 14 to 30 ppm oil, and approximately 70 tons per day of mill scale are being deposited in railroad cars.

The second step in the overall program was instituted in 1954, due to conditions brought about by the drought years of late 1952 through 1954, with installation being completed in late summer 1955. This step included the final clarification and reuse of all wastes from the bar mill and finishing stands. Gravity flow is now maintained through the sedimentation basin for all bar mill and finishing mill wastes. The effluent from the sedimentation basin is pumped to two 80 ft diam clarifiers for chemical treatment and final clarification. The clarified water is not only being returned to the mills, but is also used in place of well water on some process units. The sludge from the clarifying units is dewatered on vacuum filters and placed in the railroad car with the heavier scales from the sedimentation basin.

"ECONOMICS OF OXYGEN GENERATING STATIONS FOR STEEL MILL HIGH AND LOW PURITY OXYGEN APPLICATIONS"

by ARTHUR E. STEELE, Assistant to General Sales Manager, and DONALD E. CUMMINGS, Assistant Manager, Steel Mill Sales Division, Air Products, Inc., Allentown, Pa.

ARTHUR E. STEELE

DONALD E. CUMMINGS

▲ THE low-cost oxygen available today to the steel industry has brought forth a host of practical uses for oxygen which were only of academic interest to the steel mill metallurgist and engineer a few years ago. Among these applications are increased mechanical scarfing; expanded open-hearth use, both for decarburization and combustion purposes; carbon reduction in electric furnaces; air enrichment for blast furnaces; and recently, the top blown oxygen converter process.

This paper classifies these high and low purity oxygen applications broadly into critical and non-critical requirements from the standpoint of continuity of oxygen supply. Each application of oxygen in the steel industry is evaluated as to the most economical method of oxygen generation for the particular requirement, consistent with the desired reliability and flexibility.

"THE RELATIVE VALUE OF VARIOUS GASES FOR SCARFING"

by W. M. BLOOM, Combustion Engineer, Allegheny Ludlum Steel Corp., Brackenridge, Pa.

W. M. BLOOM

▲ THE flame generally associated with the scarfing process is the oxy-acetylene flame. However, other fuel gases such as propane, hydrogen, and natural gas are available and are often considered as possible scarfing fuels. The relative values of these various fuels are compared.

Propane, a propane mixture, and acetylene were chosen for a field test. The most economical fuel gas in regards to fuel gas and oxygen consumption, scarfing and scraping time, and wages, based on existing prices, were determined.

The results show that the cheapest fuel gas per thousand Btu is not necessarily the most economical. Investigation of preheat oxygen requirements, flame temperature, and total cost of fuel gas and oxygen offer a more complete check of a fuel's value. An attempt is

made to show that the rate of oxidation of a steel surface by the oxy-fuel gas flame is a function of: (1) area of the preheat flame gases, (2) the gas velocity, (3) the rate of flame propagation, and (4) the heat content of the fuel gas.

Very little difference was found so far as total oxygen and fuel gas cost are concerned. The propanes were the cheapest fuel gas tested, but required the largest quantity of preheat oxygen. Acetylene gas cost was greater than the propanes, but its oxygen consumption was lowest.

A more clearly defined difference between the various fuel gases is noted from an operational point of view. These operational factors are analyzed and conclusions are drawn as to the fuel gas of major importance for the scarfing process.

"THE PREVENTION OF GAS INCIDENTS"

by T. A. WATSON, Assistant Division Superintendent, Power Production, United States Steel Corp., South Works, Chicago, Ill.

T. A. WATSON

▲ THIS paper discusses plans and procedures which should prevent gas incidents or minimize the effects if an incident should occur.

Any effective program for the prevention of gas incidents requires complete planning, efficient organization and continuous training.

Planning will consist primarily of the preparation of efficient procedures for the safe operation of gas consuming equipment, including the operation of suitable apparatus for detecting and measuring toxic gas concentrations in areas where personnel must work. Since, however, there is an everpresent potential gas incident near gas producing or consuming equipment, procedures must be developed to cope with the incident should it occur.

To efficiently utilize the brief time in which a rescue must be effected, rescue plans must be carefully made and include such items as trained rescue squads, designation of storage locations where rescue equipment will be kept serviced and available for immediate use, signal systems to call rescue squads to designated assembly areas, and plans for the coordination of all agencies involved in rescue work.

Efficient organization must include the allotment of definite responsibilities to agencies within the plant, such as, training bureau, safety bureau, medical staff, equipment service shops and the operating departments, for a coordinated effort to prevent gas incidents, or to minimize the effect should one occur.

Training for the prevention of gas incidents will include familiarization with the safe practice procedures and the use of check lists developed for the safe handling and consuming of gases. Training of the rescue teams must be continuous to maintain desired efficiency in such items as rescue procedures, artificial respiration, first aid and the use of equipment employed by the rescue squad.

"CONTROL OF ATMOSPHERE GENERATORS"

by R. R. SWAIN, Manager Iron and Steel Division, Bailey Meter Co., Cleveland, Ohio.

R. R. SWAIN

▲ CONTROL of atmosphere generators involves measurement of factors which influence the final product. These measurements can be quantitative or qualitative, depending largely upon the characteristics of the fuel gas and the necessity for close control of the final product due to its influence on the material to be protected by the atmosphere produced.

Quantitative measurements involve the use of orifice meters or rotometers for volumetric measurement of rate of fuel flow and rate of air flow to the combustion chamber. Quantitative measurements are subject to error due to fuel quality changes and changes in atmosphere conditions, such as temperature, barometric pressure and relative humidity.

Where close control of the generated atmosphere is required, qualitative measurement must be read. The type of measuring devices to be used is dependent upon the application. These devices consist of density recorder, combustibles analyzers, thermoconductivity analyzer, CO_2 analyzer, infra-red analyzer and dew point measuring devices.

Success of any analyzing type instrument depends on the care with which the sample is taken. In most atmosphere generator installations, samples should be taken where the time lag is a minimum. This is particularly true where the instrument is to be used as an automatic control instrument. The gas sample should be clean and without entrained moisture. The sample does not have to be dry, but no entrained moisture can be present. The sample temperature should be at room temperature or usually not above 200 F.

Where ratio control produces a satisfactory final product, this can be provided by means of a zero governor which can be used to reduce the fuel pressure to atmospheric pressure, or with a differential zero governor the fuel can be reduced to the pressure of the incoming air.

In order to provide a wider range of operation, a pneumatic ratio controller can be used to control the fuel supply to the generator to maintain proper fuel-air ratio. Another device which is frequently used is the mixer or carburetor which is a direct acting regulator having movable ports for both fuel and air with an adjustment for changing the effective area of the air ports as compared with the fuel port.

Where close control of the final product is desired, the quality measuring devices described above are generally provided with a pneumatic controller with automatic reset.

The results obtained by installation of gas analysis control equipment in some existing atmosphere generators have been very good. In many of these installations, spoilage of products occurred frequently, and following the installation of the control equipment spoilage has been almost entirely eliminated. Good safety practices require the use of close control of atmospheres where the atmosphere is near the explosive limit.

"ELECTRICAL MAINTENANCE AT THE PUEBLO PLANT OF THE COLORADO FUEL & IRON CORP."

by H. E. WATSON, Electrical Superintendent, The Colorado Fuel & Iron Corp., Pueblo, Colo.

H. E. WATSON

▲ THE electrical department at the Pueblo plant of the Colorado Fuel and Iron Corp. is responsible for electrical maintenance in all operations, supervision and coordination of all electrical construction, operation of the electric shop, and supervision of electric cranes.

The Pueblo works of the Colorado Fuel and Iron Corp. is a diversified plant consisting of a coke plant, blast furnaces, open hearth, rail mill, 40-in. blooming mill, 20, 25, 14, and 10-in. merchant mills, a rod mill, seamless tube mill, and wire mill. Electrical maintenance, then, covers the full scope of such problems in the steel industry. The approach of these problems from the standpoint of organization and training raises some provoking questions.

Construction is supervised and coordinated in such a manner that the supervisors who will be responsible for maintenance are familiar with equipment from the time of its conception and installation.

The electrical department is intimately concerned with the selection and design of electrical equipment and works closely with design engineers.

The inclusion of electrical inspectors and cranemen in plant-wide seniority units has introduced many labor-management problems in addition to the inherent advantages of such an arrangement. The use of an electrical bull gang for construction and emergency maintenance has been a desirable arrangement.

Although the department is responsible for all maintenance and construction, including control of spares, it operates with a minimum of clerical or office overhead, and there is a decided lack of procedural formality.

The organization of the electrical department at the Pueblo plant includes a comprehensive apprentice program for electricians of all categories.

The overall plant organization at the Colorado Fuel and Iron Corp. requires the superintendent of the department to function in a variety of plant-wide committees and programs.

The key to efficient operation of an electrical department has been found to be in the proper selection and training of personnel.

Maintenance costs have been held to a minimum in face of industry-wide wage increases.

"GREATER FLEXIBILITY FOR WIRE DRAWING"

by R. C. SUTTLE, Application Engineer, Reliance Electric & Engineering Co., Cleveland, Ohio and MAURICE A. NYE, Chief Engineer, The Vaughn Machinery Co., Cuyahoga Falls, Ohio.

R. C. SUTTLE

▲ AT the Steel Co. of Canada's new Parkdale Works at Hamilton, Ont., extremely high finish speeds—in excess of 4000 fpm—have been attained on new continuous rod drawing machines. Placed in operation early in 1956, these machines incorporate the most recent advancements in machine design and regulated, electronically controlled drive equipment. This installation, in addition to one in the Pittsburgh area, marks the very latest in wire drawing equipment found anywhere in the world.

From the early 1920's to date, the ferrous wire industry has seen the speeds of continuous rod drawing machines advance from 350 fpm to the present day speeds which are in excess of 4000 fpm. It has been an evolution marked by a continuous process of alternately improving the machine design, the electrical drive system, and operating practices. Each of these three areas was worked on in turn until a point was reached, beyond which the speed could not be increased through further effort in that particular area. As a limit was reached in one area, effort was then switched to one of the other areas until its limit was reached, and so on in a constant rotation from area to area—reaching new plateaus of speed each time.

MAURICE A. NYE

The stages of development of continuous wire and rod drawing machines from the earliest to most recent types are traced. Details of mechanical design and the electronically controlled drive system are also discussed in detail, with particular emphasis on the actual installation at Steel Co. of Canada.

"PROTECTION OF MEN EXPOSED TO THE HAZARDS OF MOVING OVERHEAD ELECTRIC CRANES"

by HAROLD R. MILLER, General Foreman, Assigned Maintenance, Butler Works, Armco Steel Corp., Butler, Pa.

▲ IN this paper, the writer discusses the rules in effect at the various Works of Armco for the protection of men working on cranes, crane runways, on top of furnaces and other high places where there is danger of

being struck by a crane. These rules are published as *Armco General Safety Order No. 2.*

HAROLD R. MILLER

This General Safety Order lists the procedure to be followed in these two situations:

1. In the first case when the crane or cranes in the hazardous area can be taken out of service while work is being performed.
2. In the second case when the crane or cranes cannot be taken out of service while work is performed in the hazardous area.

This General Safety Order defines the duties of the job foreman, the department foreman, the craneman, the lookout men and members of the working crew in both situations. It outlines the procedure to be followed when there is one crane on the runway, when there are more than one, and when there are cranes operating on adjacent runways. It spells out the procedure for working in a hazardous area where there are two cranes on the runway and one can be taken out of service; where there are several cranes on the runway with the end cranes operating and the middle ones not being used. Also listed is the procedure to be followed when cranes on separate runways are operated alternately by the same craneman. The procedure to be followed by anyone getting on or getting off a crane, is established by this same General Safety Order.

In conclusion, the paper points out additional safeguards for the protection of men working in the hazardous area. It discusses the importance of a cooperative relationship among the groups working in the area. Colored slides showing the application of General Safety Order No. 2 are offered as a supplement to the paper.

"NORMALIZING AND HEAT TREATING OF STEEL PLATE"

by HORACE DREVER, President, and N. K. WILLIS, Chief Engineer, Drever Co., Bethayres, Pa.

HORACE DREVER

▲ THE production of steel plate represents a sizeable fraction of the total steel output of the country, last year amounting to over 6,500,000 tons. Very little of this plate production has been shipped from the mill in the heat treated condition, but plate of this quality is receiving increasing attention and the production is rising. A large number of uses in construction of pressure vessels, earth moving machinery, mining machinery, buildings and bridges are being found, and as the advantages of high strength combined with light weight, brings to the attention of designers the use of such materials, its use is bound to grow.

Last year there was put into production, the first fully automatic continuous high output heat treating plant which embodied a number of unusual features, and by the end of this year, a second completely integrated plant will go into operation. The authors describe features of equipment to produce economically and at a high rate, low carbon and alloy steel plate, either normalized or fully heat treated. A production line will include a hardening furnace, a tempering furnace and a pressure quench, all of the roller-hearth type. Plate is fed continuously, but upon finishing its heating and soaking period, it is discharged one plate at a time at a high rate of speed to the pressure quench, where it is cooled quickly under pressure to keep the desired flatness.

"STUDY OF FACTORS INFLUENCING SURFACE STAINING OF COLD ROLLED STEEL"

PART I — "TYPES OF DEFECTS AND THEIR OCCURRENCE"

by C. R. LILLIE, Research Metallurgist and D. W. LEVINSON, Supervisor, Non-ferrous Metals Research, Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill.

C. R. LILLIE

▲ ONE of the major surface defects of annealed cold rolled steel is a narrow gray to black zone of stain appearing near and parallel to each edge of a coil, and separated from the edge by a bright area about ½ to 1 in. wide. This black band, known variously as "snaky edge," "edge smudge," "carbon edge," or "shadow edge," renders the strip unsuitable for terne plating, certain types of galvanizing, or lacquering. Despite its common occurrence, mill variables are so numerous and difficult to control that the cause and cure of this defect had not been completely established.

The experimental attack consisted first of establishing conditions under which the defect is formed, and, second, of discovering the combination of factors by which the defect might be removed from the sheet surface.

D. W. LEVINSON

It was found that snaky edge formed independently of variations in the type and amount of rolling oil and/or detergents. Also, the reaction was shown to occur on a strip surface which had been mechanically and chemically cleaned, indicating that the presence of surface impurities carried over from continuous pickling and cold rolling was not required for the formation of the defect.

The sharpness of the demarcation line between the

dark and bright areas found on both commercial and experimental material indicates a temperature-dependent chemical reaction. The location of the defect near the edge of the coiled strip may be thought of as the result of a combination of temperature gradient from edge to center of the coil and of limited access of the annealing gas. It has been demonstrated that a temperature gradient is more important than a definite temperature of formation.

The resistance of the black area to reduction by DX gas and by hydrogen gives a clue to its persistence throughout the long annealing process, and implies that the defect is formed on the heating cycle.

It is concluded that the composition, header pressure and rate of flow of the annealing gas are the commercially controllable factors by which the formation of the defect may be minimized (increase of the CO_2/CO ratio, decrease of the dewpoint, and/or increase of the header pressure and flow rate).

PART II — "IDENTIFICATION AND REACTION MECHANISMS"

by F. SCHOSSBERGER, Senior Scientist, K. HATTORI, Research Chemist, and H. MARVER, Assistant Chemist, Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill.

▲ THE effect of a DX gas atmosphere on the staining of steel coil edges in annealing ovens is studied. Black edges of coils annealed in various steel mills were investigated by electron microscopy, x-ray diffraction and electron diffraction. One or more of the following substances were found: carbon, a variety of oxides and oxy-hydrates of iron, and iron carbides.

F. SCHOSSBERGER

At 750 C, DX gas removed black edges on only some of the samples. Chemical tests and electron diffraction data also indicated that different types of black edges exist.

K. HATTORI

Laboratory experiments indicated that the space between steel sheets, temperature, flow rate, and gas direction, all influence the appearance and extent of the stains or deposits on the steel surface. Excessive amounts of rolling oil can alter the appearance of the stain.

H. MARVER

A mechanism for the formation of the black edge is postulated from comparison of experimental results and reports in the literature. Depending upon the annealing conditions, carbides, carbon, or iron oxides are formed in different proportions by catalytic reaction of the iron surface with the DX gas.

"NUCLEAR TECHNOLOGY AND THE STEEL INDUSTRY"

by R. P. PETERSON, Director Nuclear Research, Republic Steel Corp., Cleveland, Ohio.

▲ AS the sixth largest consumer of electricity and as a large consumer of direct heat, the steel industry must be concerned with the economies of nuclear energy. The basis for selecting those areas in the steel operations where nuclear energy may be expected to appear are discussed along with estimates of the time scales when it might appear.

R. P. PETERSON

Various technological aspects of the nuclear industry are applicable to the steel industry. Examples of possible liquid metal cooling and isotope applications are given. Nuclear exitation as a chemical analysis procedure is described.

The potential requirements for special materials of construction for reactors is estimated, and some of Republic's efforts in this field are described.

"MODERNIZATION OF WHEEL HEATING FACILITIES, JOHNSTOWN PLANT, BETHLEHEM STEEL CO."

by F. R. PULLEN, Fuel Engineer, Bethlehem Steel Co., Johnstown, Pa.

▲ THE advent of the diesel locomotive along with new methods of wheel testing created new problems for the wheel manufacturers. The higher running speeds and the longer trains now pulled with diesel power subjects the finished wheel to much more severe operating conditions. As a result, it became necessary to improve still further the quality of wheels produced.

F. R. PULLEN

The wheel division of the Johnstown plant of Bethlehem Steel Co. was originally built during the first World War. At that time batch type heating furnaces were installed throughout the mill for both initial and reheating operations. The charging of cold wheel blocks into hot furnaces simultaneously with the drawing of hot steel from the furnace, or even at the completion of the discharging operation, subjected the steel to possible thermal shock. This was not conducive to good sound steel, free of surface defects in the finished wheel. In addition the inability to control the furnace accurately produced nonuniform heating of the wheel blocks.

The combination of heavier trains and higher operating speeds brought about by the conversion of the railroads from steam to diesel motive power, as well as improved metallurgical testing equipment, and pro-

cedures, made it necessary to improve the heating operation at the wheel plant.

A critical review of our wheel block heating equipment and operating practice indicated the need for new furnaces throughout the mill. As a result, a program of replacement of batch type heating furnaces with continuous rotary hearth furnaces was begun in 1951 and completed in 1954. At the completion of the program, four rotary hearth furnaces replaced six old batch and semi-continuous furnaces.

Such a program must be integrated into the mill operation in such a manner as to reduce down time to a minimum and with as little interference to operations as possible. The engineering problems involved in such a construction project were many and quite involved.

The new furnaces are equipped with automatic control of furnace temperature, fuel air ratio control, furnace pressure, and in one case, a complete automatic block handling system which starts at the steel preparation site and concludes at the first forging press.

"TRANSPORTATION CONTROL IN STEELMAKING"

by J. L. KERINS, General Transportation Manager, Steel Operating Division, United States Steel Corp., Pittsburgh, Pa.

J. L. KERINS

▲ TRANSPORTATION can be considered a synonym for material handling in the most extended sense since it encompasses the movement of goods and products from points of origin to those of consumption.

The intention of this paper is to review, with objective generality forms of transportation control presently being utilized by one steelmaking organization to attain the maximum benefits that may be realized from this broad function of material movement.

To determine the most effective objectives of transportation, it is most practical to know and understand what performances are currently experienced in operating functions in order to plot and install improvements to practices. The development of transportation costs best crystallize present actions as well as indicating future courses.

Central operations extends cost control over its transportation activities by two phases of regulation:

1. The measurement of those expenses incurred to move and handle materials from origin points to destinations for production.
2. The measurement of in-process transportation costs created by transportation expenses developed during manufacturing operations, and the handling of manufacturing by-products.

Uses of accumulated costs in the form of maintenance of trend information, comparative analysis, and techniques employed by sub-committee work within the transportation organization of United States Steel to develop standard operating practices for transportation are reviewed.

Four other types of transportation controls that supplement cost regulation, and how they can be realized, are discussed in detail:

1. *Car burden control,* a transportation tool created for the purpose of gearing production demands for delivery of materials, to the ability of plants to absorb such, and the carrier's capacity to deliver same. Development and installation of this type of transportation control has reduced mill congestion, improved plant switching practices, and improved overall transportation costs.
2. *Pattern switching control* provides stabilized lower cost transportation service through the integration of mill movement requirements with carrier service. The development of this control has resulted in improved communication between those responsibilities requesting service and those furnishing it.
3. *Car forecasting control,* a method for equipment procurement to handle trade shipments that will provide operations with the proper type of equipment, in the quality expected, and at a desired location on a scheduled time. Utilizing this type control assists industry toward attainment of the most effective practices in loading and shipping, by realizing maximum performance for loading time utilized, and aiming toward an ultimate reduction to total hours necessary to perform loading operations.
4. *Shipping performance controls* are techniques employed on a measured basis for the purpose of expeditiously moving finished products from the plants toward the customer. This type of control has an objective of indicating performances, localizing transportation "fall-downs" and evaluating corrective actions to improve the competitive position on product delivery.

In conclusion, several method improvements in transportation are presented to illustrate how the use of the aforestated controls have enabled transportation responsibilities to install new practices that delivered increased performances in conjunction with decreased cost experiences.

Transportation controls have become preeminent as tools by which management plans, develops and installs dependable and efficient operating techniques that will supply it lowest cost transportation service.

"PIPE: MANUFACTURE AND USE"

by P. D. THOMAS, Materials Engineer, Asiatic Petroleum Corp., New York, N. Y.

P. D. THOMAS

▲ SINCE the inception of the modern pipe industry 130 years ago, pipe manufacturers have faced an increasing complexity of uses which in turn has led to the development of improved methods of manufacture and inspection, wider ranges of material, and better quality of product. This trend has continued until for example today oil country tu-

bular goods—almost 100 per cent hot rolled carbon or carbon-manganese steel 20 years ago—are now at or close to the 50 per cent mark in heat-treated grades, using both carbon and alloy steels. Carbon steel tubes have in many cases been replaced by chromium and chromium nickel stainless steels, and chromium-molybdenum high temperature steels to meet the demands for higher temperature, higher pressure, and more corrosive conditions encountered in operations. The end is not in sight and there appears to be nothing constant except change. There is definitely a challenge to the tubular products manufacturer to keep abreast of demand for both increased quantity and quality of tubulars in the near and more distant future.

"EVALUATION AND SPECIFICATION OF PAINT FOR INDUSTRIAL USE"

by JOSEPH BIGOS, Senior Fellow, Mellon Institute, and Director of Research, Steel Structures Painting Council, Pittsburgh, Pa.

JOSEPH BIGOS

▲ PAINTING costs in industrial plants can be reduced by proper design, adequate surface preparation, selection of coatings capable of performing required tasks, and proper application. Proper application should include procedures which will permit the protective system to function within the practical limitations of operating plants. Correct surface preparation is probably the most important factor in determining service life. The described methods of evaluating paints for industrial use will simplify procurement of economical materials. A proposed standard for painting of steel mills is offered as a guide.

"SOLVENT DEGREASING — A VALUABLE INDUSTRIAL CLEANING PROCESS"

by W. L. McCRACKEN, Director of Research, Detrex Corp., Detroit, Mich.

W. L. McCRACKEN

▲ IN order to fully understand the process of solvent degreasing and its application in modern metal cleaning, it is necessary to know the basic fundamentals governing the design of the process. It is also necessary to know something about the various operating cycles which may be employed, depending upon the type of work to be cleaned, type of soils to be removed, and methods of material handling which is to be employed. These basic fundamentals are explained and shown graphically by illustrations.

Equally important is a knowledge of why certain solvents are employed in modern solvent degreasing practice and why they have been selected as superior degreasing solvents. Characteristics of solvents suitable for use in solvent degreasing equipment are discussed.

A cleaning process should be thorough, economical and safe. The solvent degreasing process is one of the most economical and one of the safer processes which can be applied to metal cleaning. Economics and safety are discussed in detail. The process is most adaptable and can be used as a hand operated process or can be applied to the most complicated production lines including strip cleaning lines. It is flexible and can be used in connection with other cleaning aids, such as the application of ultrasonic energy to the cleaning cycle. The application of ultrasonics to a modern solvent degreasing process is shown graphically by figures.

"SILICONE LUBRICANTS AND PROTECTIVE COATINGS IN THE STEEL INDUSTRY"

PART I — "SILICONE LUBRICANTS"

by W. H. RAGBORG, Laboratory Supervisor, and W. H. BADGER, Development Engineer, Fluids Section, Product Development Laboratories, Dow Corning Corp., Midland, Mich.

W. H. RAGBORG

W. H. BADGER

▲ SILICONE fluid and grease lubricants have found a wide variety of special applications in industry. They are of value where oxidation resistance, thermal stability, moisture resistance, low volatility, and excellent consistency or viscosity-temperature relationships are essential lubricant requirements.

Because high equipment operating temperatures are quite common in the steel industry, silicones have already solved some difficult lubrication problems. The unique properties of these materials should make them interesting in still other high temperature lubricant problems associated with the steel industry.

Development work presently under way indicates that silicone fluids with much improved load carrying capacity for ferrous metals in sliding contact can be made. Increases in high temperature stability may also be possible. Such improvements should extend the usefulness of silicone lubricants still further.

PART II — "SILICONE PROTECTIVE COATINGS"

by R. C. HEDLUND, Supervisor, Coatings Laboratory, Product Development Laboratories, Dow Corning Corp., Midland, Mich.

▲ SILICONE coatings have found wide use as finishes for steel equipment which operate at high temperatures and are exposed to weathering.

A number of commercial coatings are available for use on stacks, mufflers, and manifolds to temperatures of 1000 F. Others are used as industrial coatings and as maintenance finishes.

R. C. HEDLUND

The physical properties of silicone finishes are similar to organic coatings but their properties are quite different.

A wide variety of silicone resins are available to the paint manufacturer for use in protective coatings. This paper discusses these various resins and their use in paints. It also covers surface preparations and the many applications where silicone coatings are being used successfully as coatings for steel and other surfaces.

"EXPERIMENTAL RESULTS WITH HOLLOW ELECTRODES IN ELECTRIC STEEL FURNACES"

by W. E. SCHWABE, Product and Process Development Laboratory, National Carbon Co., Niagara Falls, N. Y.

▲ SEVERAL years ago, our company initiated a research program on electric furnace arcs for the purpose of studying the physics of such arcs in the laboratory and on production furnaces. One of the objectives was to investigate the erratic behavior of these arcs and its effect on the power released in the arcs.

W. E. SCHWABE

Experiments with hollow electrodes in the laboratory and at several production furnaces indicated that the performance of the arc is influenced by the geometry of the electrode tip. The paper is a review of results obtained during the trials discussing performance of the furnaces as to melting rate, power consumption, load surges and electrode consumption. The special instrumentation required for the relatively short term tests conducted is described and experimental data presented.

"ECONOMIC FUTURE OF THE LARGE TOP CHARGE ELECTRIC FURNACE"

by WM. B. WALLIS, President, Lectromelt Furnace Co., A McGraw Electric Co. Division, Pittsburgh, Pa.

▲ THE future of the electric furnace is dependent to a large degree on the factor of scrap. As long as the large furnace is dependent on a 100 per cent scrap charge, its future tonnage-wise is limited. A second factor which creates a problem in expansion of the electric furnace capacity is that scrap both here and abroad is becoming more and more contaminated with tramp inclusions. However, the future of the electric furnace is not as bleak as would be indicated by a look at the scrap picture alone. There are several alternate sources of charge materials which may possibly be used, if more rapid expansion of such furnaces are to take place. These are:

1. Development of practice for usage of hot metal in arc furnaces.
2. Expansion of production of hydrogen reduced ore.
3. Use of desiliconized hot metal.
4. Production of electric furnace pig iron in new designs which lower consumption of power from 2500 to 1000 kwhr, and which promise an increase in the daily output from 200 to 500 tons.

WM. B. WALLIS

In addition, in considering the economic future of the electric furnace, consideration should be given not only to open hearth hot metal, but to the top-fired and horizontal oxygen-fired converters.

"BASIC HOT BLAST CUPOLA AS SOURCE OF HOT METAL FOR STEEL PLANTS"

by E. S. HARMAN, President, E. S. Harman Corp., Chicago, Ill., and SIEGFRED TUNDER, Technical Director, Gesellschaft fur Huttenwerksanlagen, Dusseldorf, Germany.

▲ GESELLSCHAFT fur Huttenwerksanlagen (GHW) of Dusseldorf has perfected the design and operating practice on the carbon lined hot blast cupola to a point where it is more than worthy of a second look by the American iron and steel industry as a means for increasing open hearth furnace production and decreasing ingot cost.

E. S. HARMAN

The design principles now employed more closely approach those employed in blast furnace practice than those employed in the cold blast cupola with which we are familiar.

The fumes and dust emitted from the stack of a cold blast cupola are completely absent in the new design. All the cupola gas is withdrawn from the cupola several feet below the level of the charge which is maintained fairly uniform through stock line recorders. The cupola gas is cleaned and delivered under pressure for plant use. Fifty-five per cent of the cupola gas produced is used for heating the blast. Blast temperatures of 1100 to 1200 F are continuously and uniformly maintained.

SIEGFRED TUNDER

The carbon lining in the hearth lasts indefinitely, with patching around the tuyeres every six to eight weeks. This is in contrast to shutting down every 72 to 80 hrs for relining a cold blast acid cupola.

The difference in operation between the carbon-lined, basic-operated, hot blast cupola and the conventional cold blast acid cupola is just as pronounced, if not more so, than is the design. The cupola will operate on a 100 per cent charge of the cheapest grades of steel scrap, using furnace coke. Cast iron scrap and foundry coke are not required, nor is desulphurizing. The cost of metal from a carbon-lined, hot blast cupola is substantially lower than the cost of metal produced in the cold blast cupola.

The effect of cupola metal upon open hearth production rates and costs has been definitely determined over a period of three years of operation in German plants. These results definitely establish the basic-operated, carbon-lined, hot blast cupola as the most expeditious means for increasing ingot production and reducing ingot costs.

Another use for the basic-operated, carbon-lined hot blast cupola is supplying hot metal to oxygen blown converter plants. This combination affords just about the cheapest cost in terms of production and fixed charges. Decarbonizing cupola metal in the ladle for charging electric furnaces is another application.

"MEASUREMENTS FOR THE CONSISTENCY OF LUBRICATING GREASES"

by BEN HOLLIDAY, Chemist, Materials Engineering Division, Crucible Steel Co., Midland, Pa.

BEN HOLLIDAY

▲ THIS paper divulges some of the methods and instrumentations used from an historical standpoint for measuring consistency of lubricating grease. It dwells at length on the ultimately accepted NLGI standards of modern day, and includes some unusual adaptations for this system. The effects of additives, false chill, moisture and chemical instability on consistency are discussed as well as bodying agents and fillers. Methods of controlling consistency during grease manufacture are included, portraying the effect of soap types and the textures they produce and distinguishes between buttery, short, medium and long fibre, matrix, and jell structures.

"HIGH TEMPERATURE STEEL-MILL GREASES"

by JOHN SIMON, Lubrication Engineer, National Works, National Tube Division, United States Steel Corp., McKeesport, Pa.

▲ THE selection of a lubricant for high temperature steel mill service may be quite complex when all of the interrelated factors are taken into consideration. In addition to high temperatures, the grease must function under a variety of adverse conditions such as water washing, churning, extreme pressures, contamination and others. For each combination of service conditions, the user must seek a lubricant possessing a combination of counterbalancing performance factors to obtain optimum results.

JOHN SIMON

The first section of this paper attempts to enumerate the problems and service conditions prevalent in steel mills, and presents for each problem a counteracting performance factor of the lubricant. A number of illustrated laboratory test procedure sheets is presented to show how these performance requirements are evaluated at the U. S. Steel lubricants testing laboratory. A tabulation showing minimum values of performance requirements summarizes the first section of the paper.

Having satisfied the service requirements of the bearings, the user must also take into consideration the lubricants' impact of his centralized dispensing system. The second section of the paper tells how poor pumpability, excessive separation, varnish formation and abrasive fillers may impair the efficiency of the systems.

Subtitled "Characteristics of High Temperature Greases" the third section of the paper enumerates both the desirable as well as the undesirable features of the fol'owing greases: synthetics, the non-soap clay and gel thickened oils, the soap type greases including calcium-complex, barium, lithium, soda-lime and the conventional calcium.

Literature stressing the melting features of high temperature greases have had a tendency to exaggerate the importance of that property. A chart showing the relationship between melting point and the maximum temperature usability of the greases listed above is included.

"STOPPING CORROSION BY THE USE OF RUST PREVENTIVE COMPOUNDS"

by R. P. MILLS, Manager, Rust Preventive Division, Valvoline Oil Co., Division Ashland Oil and Refining Co., Freedom, Pa.

R. P. MILLS

▲ CORROSION is an ever present enemy which is attacking our metallic wealth with ever increasing ferocity and destroying billions of dollars of manufactured items each and every year.

There are several ways to fight this attack, principally by painting, plating, chemical treatments, porcelain enameling, vapor phase inhibitors, and specially prepared oils, greases and solvent mixtures.

In order to fight corrosion, it is necessary to understand the simple basic features of electro-chemical corrosion. In order for corrosion to proceed, there has to be set up an electro-chemical cell consisting of four parts.

1. Anode.
2. Cathode.
3. Electrolyte.
4. Connecting circuit.

The purpose of any protective coating is to interfere with the above mentioned electro-chemical cell.

In the processing of manufactured goods produced by steel mills, economy is of prime importance because of the tonnage involved. An economical way to prevent corrosion (rusting) is by the use of special types of rust inhibited oils, greases or solvent dispersions.

The Department of Defense has been one of the prime movers in the development of rust preventive compounds and much is owed to such laboratories as the U. S. Naval Engineering Experiment Station, Naval Air Material Command, Wright-Patterson Air Force Base and Rock Island Arsenal. Their work during the war and after has led to many improved test evaluation methods, packaging procedures and new protective coatings.

The laboratory personnel use such accelerated test methods as the salt spray, humidity cabinet and weather-o-meter. These tests are at the best good screening methods, and the "acid" test of any protective coating is actual mill or field experience.

Rust preventives do stop corrosion (rust) and can save money.

"SEAMLESS TUBE MAKING BY THE CALMES PROCESS"

by DR. ALBERT CALMES, Albert Calmes & Co., Milan, Italy and CLYDE ROBERTS, Chief Engineer, Phoenix Iron and Steel Co., Phoenixville, Pa.

DR. ALBERT CALMES

▲ THE main operations of the seamless tube making process at Phoenix Iron & Steel Co. are the ingot heating, press piercing, skew roll elongating, rotary forging mill (often known as pilger mill), reheating, sizing, polishing, and finishing. The mill at Phoenix Iron & Steel Co. was designed to make seamless tubes from 5½ to 16 in. in diam with a wall thickness of ¼ to 3 in. using round corrugated ingots up to 8000 lb. The seamless tube mill at Phoenixville was designed to manufacture quality pipe with close tolerances on both the outside diameter and wall thickness using cast ingots as the raw material. The press piercing, skew roll elongation, and rotary forging work together on one heating cycle to give this desired feature. This paper deals mostly with the press piercing, elongating and rotary forging of the process.

CLYDE ROBERTS

The hydraulic piercing press was selected as it was the only known means to pierce cast steel ingots without creating inside laminations or fissures. It also makes the steel structure more homogeneous and helps to increase the tube yield of the cast ingot. The hot ingot is received by the piercing press, inserted into a container and a hole is pushed into the ingot with brute force. The container determines the outside diameter of the bottle and the punch determines the inside diameter.

The bottle is conveyed from the piercing press to the elongator where the pipe is rolled over a piercing point with rolls very similar to the Mannesmann mill. The elongator lengthens and also makes a hollow bloom out of the bottle. The type of elongator rolls, guides and piercing point were selected because of the high ratio of the diameter to the length of the hollow bloom. However, the elongation is held to two or under.

The rotary forging mill, which is often known as the pilger mill, is a process of forging the hollow bloom over a mandrel. The rolls are so shaped as to cause a flow of metal over the mandrel in the direction opposite the rotation of the rolls. A feeder table feeds and rotates the hollow bloom and mandrel in order that the pipe is given a smooth surface. The rotary forging mill determines the outside diameter of the pipe and the mandrel bars determine the inside diameter. The rotary forging mill was selected because it was the best finishing mill to manufacture pipe from cast ingots. The mill is a forging process which has an elongation which may run as high as ten to one.

The Calmes process gives a practical solution to the problem of equalizing the seamless tube. It also enables the inside and outside diameter to be held to very close tolerances.

"WEIRTON MODERNIZES ITS HOT MILL"

by L. A. FUGASSI, Assistant Chief Engineer, Weirton Steel Co., Weirton, W. Va.

L. A. FUGASSI

▲ BEGINNING with the first continuous wide strip mill in 1927, Weirton has progressively improved the operation of the mill until the latest modernization program which was completed in 1956. After tripling the rated capacity of the original mill, the first modernization occurred in 1945 and from this date progressed to a point where practically an entire new mill was planned and installed.

The new mill is capable of receiving the heaviest slab in the industry's history. This slab is 48 in. wide x 9½ in. thick x 26 ft long weighing 39,800 lb. The weight per inch of width is 830 lb. In the new mill are three of the largest slab furnaces ever built. The furnaces with 28 ft hearths are 96 ft-3 in. long and rated at 200 tons per hour each.

One vertical edger, three 2-high roughers, two 4-high roughers and six 4-high finishers deliver steel to three mandrel type downcoilers located 426 ft from the finishing stands.

All latest improvements in automation and electronic control have been provided on the new mill.

"AN AUTOMATIC SYSTEM OF FUEL CONTROL"

by D. R. MATHEWS, Open Hearth Superintendent, Alan Wood Steel Co., Conshohocken, Pa.

D. R. MATHEWS

▲ PRIOR to January 1, 1955, Alan Wood Steel Co. had a long history of selling by-product coke oven gas to a local utility for domestic heating purposes. When notified that the contract was to be terminated, intensive studies were made as to the use of fuel within the plant so that intelligent plans could be made for the use of this gas without waste.

The paper deals generally with the entire gas distribution system, showing location of various purification and control units, main and branch lines, etc. It deals specifically with how the open hearth furnaces are automatically used as a balance wheel for the system, or a dumping ground for all gas that is not used in other departments.

All the first helper has to do is set his board for the total amount of fuel he wishes to burn, and at the percentage of this total that he wishes to be coke oven gas, then make sure that all instruments are set on "automatic." From that point, the instruments take over. The automatic controls are described in detail.

A unique feature of the control system is the ability of the operator to preset the sequence of furnaces automatically starting to use coke oven gas when it becomes available.

The results, after a full year of operation, are then summarized, forcing the conclusion that the company has benefitted considerably from the new system.

This paper is written by an operator, and with an operators viewpoint, not that of an instrument engineer.

"MODIFICATIONS TO THE FONTANA OPEN HEARTH PRECIPITATORS"

by E. V. AKERLOW, Assistant Division Manager, Kaiser Engineers, Steel Division, Oakland, Calif.

E. V. AKERLOW

▲ THIS paper reviews the recent design modifications of the electrostatic precipitators that are being installed on the open hearth furnaces of the Fontana plant of Kaiser Steel Corp.

The problem of dust removal is reviewed, and dust analysis, dielectric characteristics of dust, and particle distribution of dust in relation to precipitator operation are discussed.

The tests on the latest precipitator installation at the Fontana plant and methods of recording the test data are reviewed. They indicate gas flow and measurement of precipitator efficiency.

The studies and field testing of electrical equipment to obtain automatic precipitator control are discussed. Efficiencies and important benefits gained through the use of such equipment are covered.

The previous paper by the author dealt with the background of Fontana precipitator installations and design data relative to the precipitator installation. This final paper reviews the details of dust removal, automatic control and physical changes and design details to obtain greater precipitator efficiency. Essentially these remaining items not originally discussed in the first paper are concluded in this second representation.

"THE ALL-BASIC OPEN HEARTH FURNACE"

by R. P. HEUER, Vice President and M. A. FAY, Assistant General Sales Manager, General Refractories Co., Philadelphia, Pa.

R. P. HEUER

▲ THE history of the development of the all basic furnace, both here and abroad, is reviewed from the inception of this development in the early 1930's, to the present time. This period covers the earliest trials and developments up to and including the presently successful operations.

The construction of the present all basic furnace is described with discussion of the changes in technique which evolved to the present arrangements, including both flat and arched roofs. The more critical factors of construction technique are identified and suggestions are made as to further possible improvements and as to areas where further research is needed to obtain better results.

M. A. FAY

The refractories used in all basic furnaces are discussed, with emphasis on recent developments of refractories for basic main roofs. Front wall problems and their solution, back wall refractories and refractories for basic ends are discussed. The necessary characteristics for satisfactory basic checkers are described.

The operation of all basic furnaces is reviewed as to results comparative with silica furnaces in the light of the several changes in open hearth operations which have occurred in the last decade. These include the use of higher firing rates, redesign of furnaces for larger heat size and/or greater hearth area, and the increasing use of oxygen.

The present economy of the all basic furnace is discussed and comparison made with silica furnaces. A summary of the future outlook for the all basic furnace is presented including a discussion of possible improvement of open hearth operations through improved regeneration, better heat transfer in the furnace chamber,

and greater furnace availability, all of which are practicable only with all basic furnaces.

A bibliography of the literature related to the all basic furnace is listed.

"AUTOMATIC GAGE CONTROL FOR COLD REDUCTION MILLS"

by R. A. PHILLIPS, Analytical Engineering Section, and H. S. MAXWELL, Steel Mills Systems, Application Engineering Section, General Electric Co., Schenectady, N. Y.

R. A. PHILLIPS

H. S. MAXWELL

▲ THE paper discusses the application of automatic gage control systems to several types of cold reduction mills, five stand tandem mill for strip steel, single stand mill for aluminum foil, sendzimir mill for strip steel and titanium, and two-stand tandem mill for aluminum strip. The theoretical behavior of the various mills during both steady state and transient operation is discussed as a background for explanation of the differences in gage control application for each of the mills described. The use of modern analog and digital computers in the solution of the complex equations is explained.

On those mills where automatic gage control systems are now in service, a summary of the operating experience to date is given.

"AUTOMATIC GAGE CONTROL AND PRODUCTION ANALYSIS ON A 'Z' MILL"

by J. W. HOPPER, JR., Gage Application Engineer, Pratt & Whitney Co., Inc., West Hartford, Conn.

J. W. HOPPER, JR.

▲ INSTALLATION details, performance of various components, and the over-all performance of an integrated system of automatic gage control and production analysis equipment installed on a 26-in. sendzimir mill are discussed and illustrated in this paper. The system is unique in the means used for maintaining precise gage control as well as having several new approaches to the tabulating of product quality data.

The gaging medium used to detect strip thickness is x-ray in principle, one unit on each side of the mill. For control purposes the gages feed a signal to a unit which varies the payoff or back tension, within preset limits to compensate for small variations in strip thickness as detected by the exit gage. If the deviations from the nominal size are of sufficient magnitude to be outside of the range of the tension control, automatic corrections are made to the screwdowns to keep the exit stock on gage.

For production analysis purposes, accumulating footage counters are provided on the operator's desk to show the total, undersize, oversize, and on-gage footage. Repeater printing counters are provided in a card printing attachment which provides a permanent numerical record of the condition of the coil produced. A direct reading recorder chart, the length of which is proportional to strip footage is also produced, showing the exact thickness of the material at any specific location in the coil.

The control and production analysis signals and functions have been integrated to provide automatic reversing and reset as the mill changes direction for successive passes, relieving the mill operator of many minute details to insure good system performance.

"AUTOMATION AND ITS TOOLING AND THE CONCEPT USED AT INLAND STEEL CO.'S NEW RAIL JOINT LINE"

by C. E. CHAPMAN, Superintendent, Rail Accessories Department, Inland Steel Co., Indiana Harbor Works, East Chicago, Ind.

C. E. CHAPMAN

▲ THE outline of this paper concerns the economical reasons for considering the use of automation, the extensive planning, and detailed engineering study required to build a system that will function efficiently, consistently, and accurately.

Various types of automation and the early stages of its development are considered. Its close connection with labor relation problems are touched upon. Inland Steel Co.'s automated joint bar line is discussed, and why it was installed. Illustrations are shown covering the following units:

1. Charging skids.
2. Shear feed automation.
3. Shearing discharge equipment and furnace charging equipment.
4. Furnace conveyor equipment.
5. Furnace discharge take-off.
6. Furnace to first press catapult mechanism.
7. Presses and feed automation.
8. Press tooling.
9. Heating for quenching.
10. Discharge mechanism.
11. Quenching practice.
12. Quality control practice.
13. Surface and quality inspection.
14. Piling and loading practice.

"EDGE POSITION CONTROL FOR THE STEEL STRIP INDUSTRY"

by FRANK J. MARKEY, Manager, Edge Position Controls Division, Askania Regulator Co., Chicago, Ill.

▲ EDGE position control is applied to continuous processing lines in many forms. Since edge position controls are generally applied to the pay-off and wind-up reels, the bulk of this paper is devoted to these applications. The physical requirements of the pay-off reel application are almost opposite to the requirements of the wind-up reel application. The location of the entry and exit idler rolls greatly affect the automatic edge position control system. It is explained how the location of these rolls affects the system's response. The automatic floating edge position control is defined and an explanation of its operation is given.

FRANK J. MARKEY

The system components, such as the hydraulic work cylinder and hydraulic power unit, are determined by the total weight to be moved and the rate at which it must be moved to maintain required strip position. A method for determining these components is introduced. An edge position control system is presented for accurate guiding of strip at intermediate points within the process. Other types of edge control follow up applications are also included.

"ROUGHING MOTOR INCHING DRIVES"

by DR. ROGER SHIELDS, Development Engineering Department, Elliott Co., Jeannette, Pa. and H. KERMIT FISH, Assistant Electrical Superintendent, Weirton Steel Co., Weirton, W. Va.

▲ THIS paper describes the design and application of a mechanical inching unit for rolling mill service. As contrasted to electrical inching methods for roll positioning, the mechanical unit engages the main mill drive shaft directly to provide slow speed rotation of the roll—in either direction—without use of the main motor electrical system. The first section of the paper describes the design basis and details of the mechanical inching unit. Its operation and performance as applied to a roughing mill drive is described in the second section.

DR. ROGER SHIELDS

H. KERMIT FISH

"BASIC DATA ON MECHANICAL CLEANING OPERATIONS IN STEEL PLANTS"

by GILBERT D. DILL, Engineer in Charge of Steel Division, Wheelabrator Corp., Mishawaka, Ind.

▲ THIS paper covers a brief history and gives data on the mechanical cleaning process and the basic requirements which it has had to meet to achieve its present acceptance as a means of descaling hot rolled steel products. This acceptance is confirmed by more than 100 installations.

GILBERT D. DILL

It also describes key installations and gives basic operating and cost data on the following applications:

1. Conditioning ingot molds.
2. Descaling of slabs and billets for inspection.
3. Strip cleaning—both carbon and alloy steels.
4. Sheet cleaning—both carbon and alloy steels.
5. Descaling bar stock and extrusions for cold drawing.
6. Descaling wire rods for cold drawing.
7. Descaling structural steel for fabricating, painting and/or galvanizing.
8. Blast etching of mill rolls in pairs.
9. Miscellaneous special applications.

Each of the above items is covered by a key installation and the advantages derived from the use of this process are highlighted.

The paper concludes with a forecast of the future economies which can be secured by the steel industry through the application of mechanical cleaning and the savings which can be derived through automation and lower costs.

Are you annoyed by having someone borrowing your magazine when you want it? Get him to join the AISE.

By
E. O. AUSTERMILLER
Chief Engineer
and
W. A. SMITH
Superintendent, Power and Fuel Dept.
National Tube Division
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McKeesport, Pa.

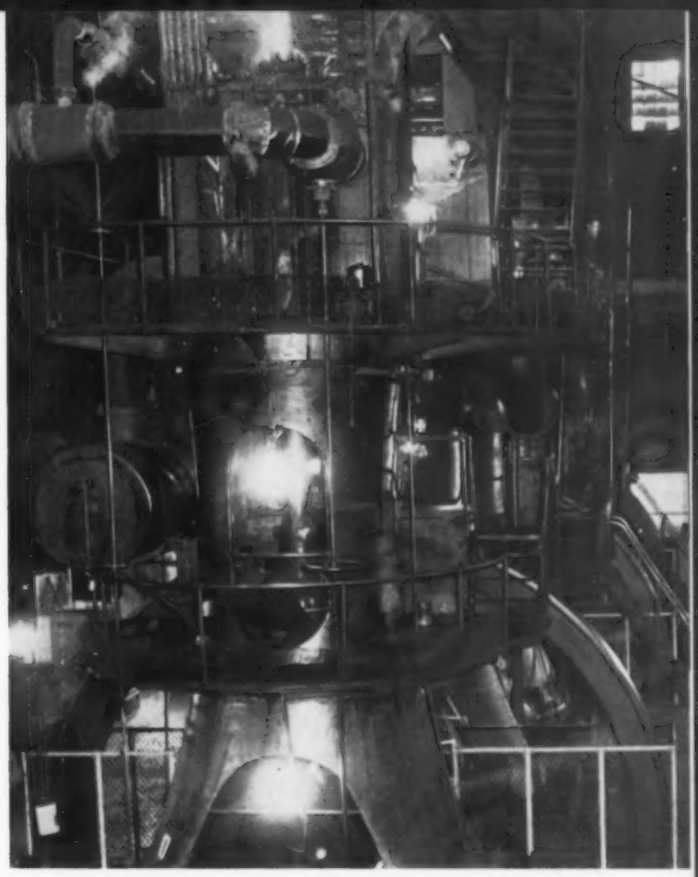


Figure 1 — Three of the nine vertical blowing engines were dismantled. The other six were kept as standby.

the installation of, and split wind blowing with,

Topping Turboblowers for Blast Furnaces

An unusual operation is the use of two turboblowers to handle three furnaces . . . . unique also is the use of topping units which has resulted in increased efficiency and very appreciable fuel savings.

▲ THE installation of the two topping turboblowers at National Works was the second step of a two-step modernization program. The first step was the building, in 1949, of a high pressure boiler house consisting of five boilers, each with a capacity of 175,000 lb per hr of steam at 850 psi, 750 F total temperature.

These two steps were planned to permit a possible third future step, the installation of a 25,000-kw admission, extraction, condensing turbogenerator and the electrification of the No. 1 blooming mill.

Prior to the installation of the topping turboblowers, steam was produced at four boiler houses in which were three waste heat boilers, having a capacity of 60,000 lb per hr of 150 psi at 550 F total temperature of steam, boiler house "T," having a capacity of 160,000 lb per hr saturated steam, boiler house "L," producing steam for the production of electric power with a rating of 180,000 lb per hr of steam at 250 psi, 550 F, and central boiler house, having a net capacity of approximately 700,000 lb per hr of steam at 850 psi, 750 F. This 850-psi steam was initially discharged through two 500,000 lb per hr reducing and desuperheating stations located in central boiler house. This provided 150 psi, 425 F steam for plant use. Two 16-in. headers, designed for 850 psi, 750 F were provided from the discharge of the pressure reducing stations to the blowing room, a distance of approximately 1000 ft. These lines were installed for the future use of 850-psi steam to turboblowers in the blowing engine house. A 4-in. line also parallels the two steam lines and is used to carry 240 F water from the boiler house to desuperheater stations located at the exhaust side of the turbines and the reducing stations.

The blast furnaces were being blown by nine vertical blowing engines. In addition to these, a 26-in. line, approximately 1000 ft long, was connected to No. 1 and No. 2 blast furnaces with the header at the bessemer

turboblowers so that one of the 35,000-cfm bessemer turboblowers could be used for blast furnace blowing with the vertical engines.

With the installation of the two topping turboblowers, it was possible to discontinue the sending of approximately 400,000 lb of steam per hr through the reducing stations and send it through the topping turbines instead, using this steam again in the main plant steam system.

The two turboblowers were to be installed in the blowing engine house, necessitating the dismantling of three 33,000-cfm vertical blowing engines which are shown on Figure 1. The other six vertical blowings were kept as standby.

The construction of the turboblowers was planned to have as little interference with plant operations as possible. At the time construction started, the plant was at 100 per cent operation with the four blast furnaces operating using nine vertical blowing engines and one bessemer turboblower to provide the necessary wind to the furnaces. Under these conditions, the construction program was set up to have one turboblower installed in the location of No. 3 blowing engine and in operation before starting the installation of the second turboblower.

Construction was started in August, 1953 but in January, 1954, business conditions caused one blast furnace to be shut down and another to go down in February. With these conditions existing, the construction program was changed to permit both turboblowers to be installed together.

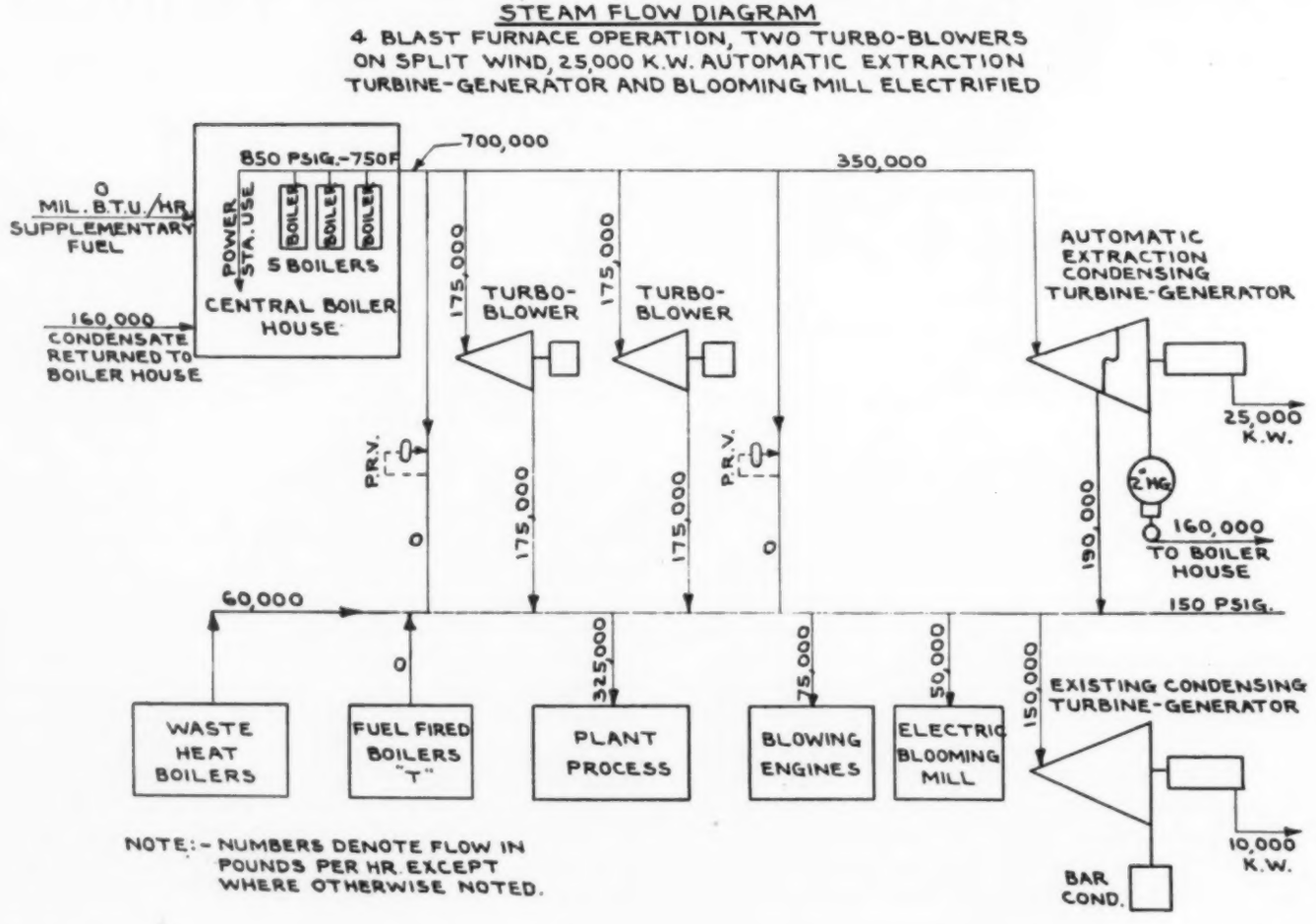
The two topping turboblowers are rated at 90,000-cfm and 30 psi and are 4-stage machines. Inlet steam conditions of the turbine is 850 psi, 750 F, and exhausting at 150 psi and about 450 F, the horsepower output of each turbine being 10,400. They are 7-stage machines.

Lubrication of the turboblowers is provided by an oil system for each unit. The oil system has a 1200-gal storage tank and an oil conditioner connected to the turbine oil reservoir.

A capacity of 90,000 cfm was decided upon when it was proposed to enlarge the hearth of No. 4 blast furnace from 22 ft-5 in. to 26 or 27 ft. However, after the blowers were purchased, the idea was abandoned. Since the requirement of each plant furnace was about 60,000 cfm, it was decided to explore the possibility of blowing three blast furnaces with two blowers or using split wind blowing. The study proved that this idea was feasible and it was decided to do so.

For full load of 90,000 cfm at 30 psi, each turbine will use approximately 200,000 lb per hr of 850 psi, 750 F steam and will reduce this amount of steam to 150 psi at 450 F. The steam is discharged into a new 24-in., 150-psi, 450 F, steam line through desuperheating stations. Each desuperheating station located in the discharge lines of both turbines has a capacity of 400,000 lb per hr, and are connected so that either can handle the discharge steam of both turbines if necessary. The new 24-in., 150-psi steam line was run through the blowing engine room and connected at each end to the existing 150-psi lines. The piping is so arranged that the two turbines can operate from either line from the boiler

Figure 2 — A steam balance for blowing split wind is shown on the diagram.



house or separately from either line. The low pressure steam system and the topping turbines are adequately protected from excessive pressure or back pressure, in the latter case by two electrically operated safety valves which relieve 50,000 lb per hr each at 160 psi and twelve spring loaded relief valves which relieve 100,000 lb per hr each at 165 psi. A steam balance for blowing split wind, assuming the installation of a 25,000-kw automatic extraction turbine generator and electrification of the blooming mill, is shown on Figure 2.

Air is brought to the blowers through 66-in. air intake stacks from the roof of the blowing room, 77 ft above the level of the blowing room floor. Rotating wire screen filters, immersed in oil, are provided for each blower. A venturi nozzle is provided for the metering of the air to each turboblower. An actual air recording meter for the air flow to each blower and a manometer type indicator to show standard air are provided.

Each blower discharges into a manifold which serves two furnaces with a waste line, check valve, and manually operated gate valve between. No. 1 turboblower header is connected to No. 2 and No. 4 furnace cold-blast mains through motor operated gate valves. No. 2 turboblower header is similarly connected to No. 1 and No. 3 furnace cold-blast mains. The two sections of these headers are connected together by means of two 30-in. lines, each equipped with a motor-operated gate valve. The six 30-in. valves referred to are controlled by switches and indicator lights mounted on the main panel board, Figure 3. (This is the control board minus the split wind control.)

With the above manifold arrangement of cold-blast piping it is possible to:

a. Blow either No. 2 or No. 4 furnace with No. 1 blower and either No. 1 or No. 3 furnace with No. 2 blower (volume blowing from the venturi in the intake).
b. Blow any one of the four furnaces with either blower when the other is down.

In order to communicate with the blast furnaces, two separate systems of communication are installed. The first, and the one that is used to operate the furnaces and the turboblowers, is a system which provides:

1. A siren which calls either to each furnace cast house or from each furace cast house to the turbine floor with an indicating light showing the number of the furnace.
2. An answering button which advises the party that the signal has been received, and
3. A selsyn motor-operated signalling system which will indicate full wind, stand-by, check and slow blast.

Upon receiving a signal from the blast furnace blower, the turbo operator will answer the signal and then follow instructions shown on the selsyn indicator, always being sure never to allow the pressure to fall below 5 psi unless notified by his foreman that the blower is to be taken off the furnace. The signalling system is mounted on No. 5 panel together with the turbine auxiliary controls and indicating lights and the motor-operated valves controls for the cold-blast main valves to the various furnaces.

In addition to the selsyn communication system, there is provided a two-way, public address system between the turbine operating floor and each blast furnace and also to central boiler house. This system is used for conversation only and would be used in case of failure to the selsyn communication system. The selsyn system is used entirely for operating the furnaces and the turboblowers.

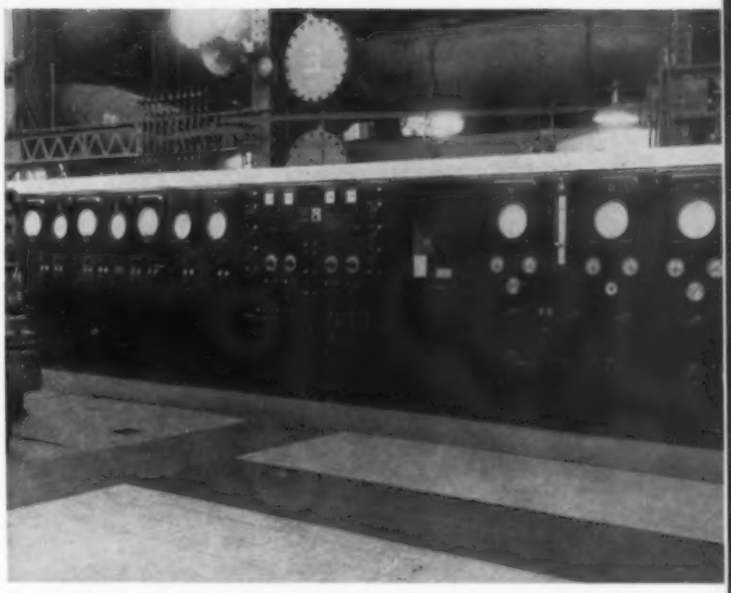
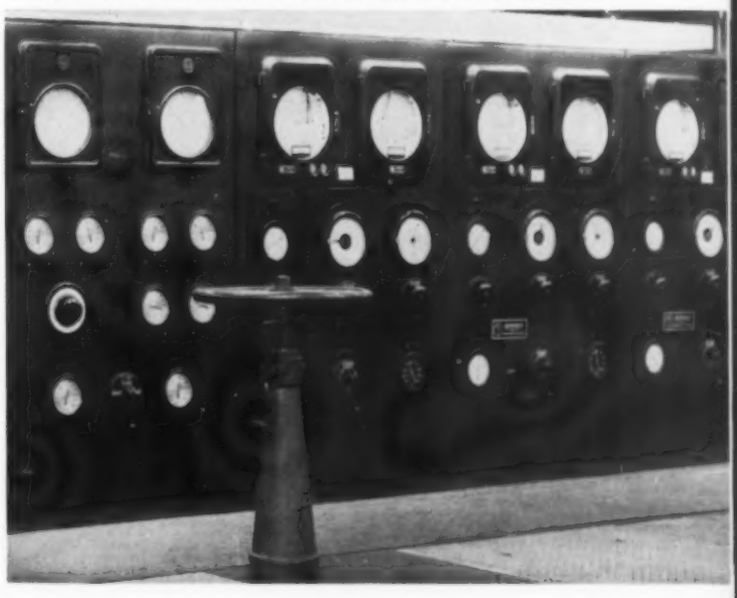


Figure 3 — Main panel board is shown without split wind control.

The operator's platform for the turboblower is 24 ft above the foundation level which was the level of the blowing engine house floor. The two turboblowers were set on base plates at the operating floor level facing east and west with all piping and accessory equipment located under the operator's platform with the exception of the throttle-valve handwheel and the steam inlet to the turbine. The operator's platform consists of precast concrete slabs set on supporting steel beams and the concrete covered with red tile. There are three reducing stations in parallel with the two turbines, two 300,000 lb per hr and one 500,000 lb per hr. The controls

Figure 4 — Split wind control panels added to the main control board included a master pressure regulator panel and a panel for each of the three furnaces.



for the reducing stations and desuperheating stations are air operated.

This control air is supplied by a small steam turbine-driven air compressor located on the blowing engine house floor under No. 1 turboblower. The controls for the turboblowers are hydraulically operated and this system has an oil storage tank and two pumps, one steam driven and one electrically driven, and necessary piping to the controls. Normal operation is electrical. If the power fails, the steam starts automatically. There is just one control system for both turboblowers.

No. 1 turboblower was placed in operation July 29, 1954, blowing wind to No. 2 blast furnace, and No. 2 turboblower was placed in operation on No. 3 furnace September 20, 1954.

Split wind control panels were then added to the panel control board, consisting of a master pressure regulator panel and panels for each of the three furnaces as shown on Figure 4.

In order to blow split wind with these blowers it was necessary to provide a volume control in the cold-blast main to each furnace, and a control to operate each blower to maintain predetermined pressure in the discharge header for each blower. This was provided with:

1. A piston-operated butterfly valve in the cold-blast main provided with a 6-in. bypass to provide minimum opening to each furnace in case of failure of impulse or hydraulic oil control line. This valve is operated by volume controls.
2. An orifice plate suitably located to measure the air through each butterfly valve with indicating and recording meters located in the main panel board.
3. An indicating pressure gage on the panel board showing the pressure on the furnace under question and an indicating thermometer located on the panel board showing the temperature of the air going through the orifice.
4. A pressure regulator is provided to control a set pressure in the cold-blast manifold by controlling blower speed.

Since major portions of the orifice impulse lines and hydraulic oil control lines are installed outdoors, the lines are wrapped with electrically heating wire and lagged overall with felt and tar paper insulation.

Physical measurements for safe and economical operations are either recorded or indicated by suitable instruments for split wind control for each of the furnaces. Air measurement is pressure and temperature compensated at orifice conditions to read in terms of standard air volume. Header and furnace pressures are recorded and also measured by dial pressure indicator.

Butterfly valve position indicators are provided to inform the turbo operator that the air volume and pressure on each furnace is at a safe and economical level. An indicating thermometer, showing the air temperature at the orifice, gives the other measurement needed for manual compensation of the air volume regulator setting.

In order to place the two turboblowers on split wind blowing on three furnaces, the turbo operator proceeds in the following manner:

With each blower handling one furnace on volume control, the first step is to establish a control pressure point on the single master regulator dial. This regulator will receive its primary impulse from the side of the common header into which the first unit to be put on pressure blowing is discharging. The master regulator converts the primary measurement into an oil loading pressure which appears at a remote manual loading station for the blower. At the respective furnace control panel for which this blower is operating, a volume setting slightly above the volume on the blower is made on the furnace volume regulator and the regulator set for automatic volume control. To transfer the master regulator signal to the turboblower regulator, a manual oil loading pressure is increased from a zero loading to the oil pressure setting required by master regulator for the predetermined air header pressure required, which would be slightly higher than normal header pressure on volume blowing. While increasing the oil pressure manually, the turbo volume regulator spring loading has to be backed off (by means of the furnace checking device) at an equivalent rate to prevent changing the volume setting at this stage. When the master loading signal has been applied to the turbo volume regulator, the turbo will then respond to the master loading primary impulse. A slight increase of flow to the furnace will be noted until the furnace volume regulator is adjusted to the correct volume required on the furnace. As the butterfly valve in the cold-blast line is throttled to establish this volume, the master pressure regulator can then be adjusted to a pressure adequate for overcoming metering and line resistance.

The foregoing would establish pressure blowing of one turbo blower on one furnace. The second turbo unit, blowing a second furnace on volume measurement on the inlet stack venturi, would be transferred to pressure blowing of that furnace in a manner similar to putting the first unit on pressure blowing. After both units are blowing into each side of the common header at equivalent pressures, the segregating valves on this header are opened, thus allowing both blowers to operate in parallel, supplying wind to two furnaces.

To blow three furnaces from this common header, the operator will slowly open a third motorized valve to the third furnace cold-blast line, usually on reduced wind and manually throttling by means of the automatically-operated butterfly valve to maintain reduced volume and pressure to the furnace until full wind is called for.

An additional volume regulator for each turboblower operates a waste valve on the blower discharge line between blower and check valve. During operation this waste valve is normally closed but will open if the minimum volume set on the control is not being discharged. This feature is provided to eliminate pumping when it is necessary to operate the blower at a small volume and a relatively high pressure. The setting on this valve is 35,000 cfm at present.

A maximum pressure of 24 psi is maintained in the main air header on "split wind" blowing to feed three furnace cold-blast lines. This permits operation on full wind with minimum pressure drop for volume measurement by means of annular orifice, and volume control by means of volume regulator and butterfly valve. Above normal furnace pressures is noted first by a signal light indicating 85 per cent butterfly valve opening. Any further increase in valve opening is indicated on a

panel-mounted valve-position indicator in the turbo room. Compensation can either be made by immediately increasing header pressure or by notifying furnace operator to make observation of the furnace and call for a check if such procedure is in order.

Furnace checking procedure using turboblowers on volume blowing has been modified slightly. Using positive displacement compound blowing engines, three signals for taking wind off the furnace are employed. The first signal for check means 20,000 cfm less wind, the second check another 10,000 cfm less wind, and the third check, or equivalent to stop, enough additional wind off to maintain 5 psi in the cold-blast header. A check signal while turboblowing means 20,000 cfm less wind. Further checking to lower furnace pressure is controlled at the furnace by means of the free blow or snort valve. A signal for slow blast or stop at the turboblower room means to maintain 5 psi on the furnace pressure gage as in engine blowing. Air volume on slow blast is between 25,000 and 30,000 cfm, but regardless of amount of free blow, the 5-psi, cold-blast line pressure is strictly maintained.

Volume measurement to each furnace is made by pressure and temperature compensated flowmeters corrected to base conditions of 60 F and 30-in. Hg. Volume regulators are equipped with pressure and temperature compensating devices which are manually adjusted for flow conditions at the point of measurement. This feature permits the turbo operator to add or deduct standard units of air with a single dial control on the regulator control setter.

Present readings with No. 2, 3 and 4 blast furnaces on the two turboblowers are, blowing 61,600 cu ft at 19.1 psi to No. 2 furnace, 54,500 cu ft at 18.7 psi to No. 3 furnace, and 54,000 cu ft at 18.4 psi to No. 4 furnace. With this amount of standard wind going to the three furnaces from the two topping turboblowers, No. 1 turboblower is using 185,000 lb of steam per hr and No. 2 turboblower is using 181,000 lb of steam per hr at 840 psi, 738 F. For the period from April 1 through June 30, 1955, the total plant load consisted of this steam through the topping turboblowers plus an average of approximately 92,370 lb per hr through the south reducing station, the only one in service during that time. Coal consumption for this period was an average of 12.7 tons per day.

The average operating day with four blast furnaces is best shown by a quick look at some of the charts. Figure 5 shows the pounds of steam per hour through two steam turbines and the reducing station operating in parallel with them. Figure 6 shows the discharge pressure and temperature of the two steam turbines and the steam pressure on the high pressure side of the two turbines. Figure 7 shows the pressure maintained in the header and the output of the two blowers. Figure 8 shows the amount of wind to each blast furnace and Figure 9 shows the pressure of the blast at each furnace.

At a four blast furnace capacity level of production and with the old equipment, it was necessary to operate central boiler house, boiler house "T" and the waste heat boilers for the production of 150-psi steam, and boiler house "L" for the production of steam for the 10,000-kw generator. Installation of two topping turboblowers with split wind blowing shows a net steam savings as calculated sufficient to scrap boiler house "L." The Btu chargeable to blowing the furnaces with these topping turboblowers are only about one-third the Btu that would have been required by a modern condensing steam turboblower installation. Exhaust from the top-

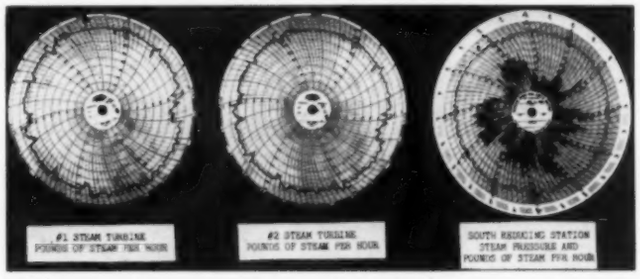


Figure 5 — Steam requirements for 24 hours are shown by the chart.

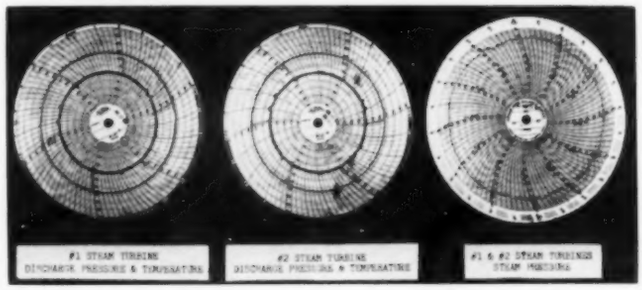
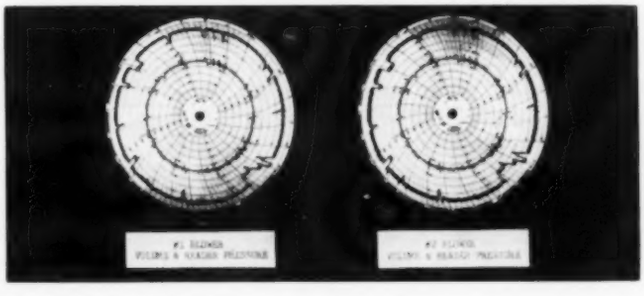


Figure 6 — Discharge pressures and temperatures are given for steam turbines.

Figure 7 — Volume and header pressures are given for 24 hours for the two blowers.



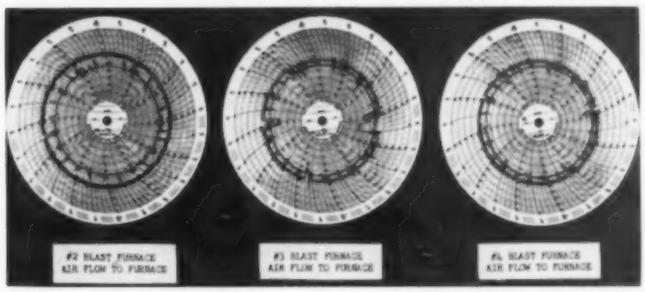
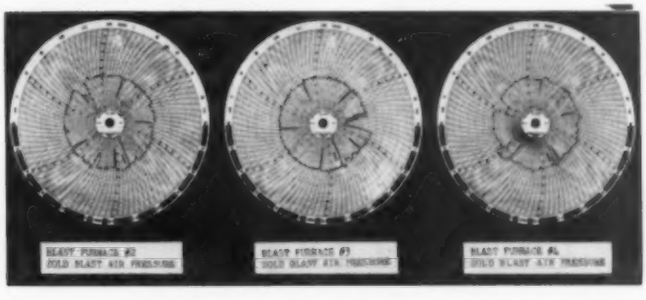


Figure 8 — Chart shows quantity of wind for the three blast furnaces

Figure 9 — Blast pressures at each furnace are given for 24 hours



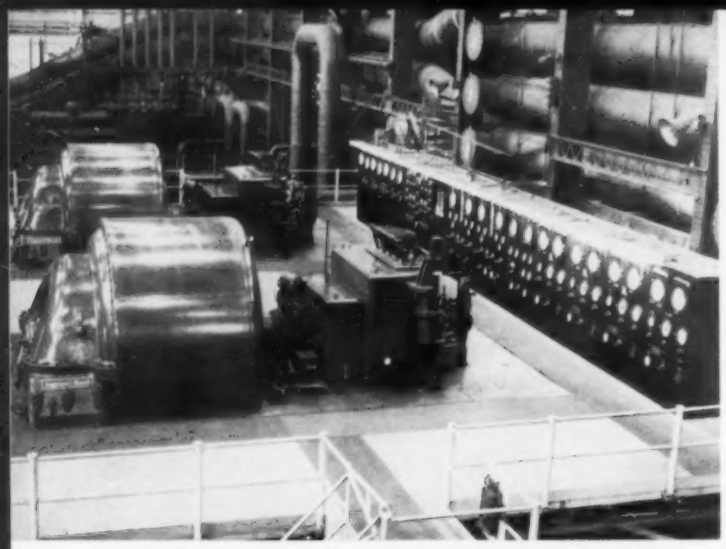


Figure 10 — In the completed installation, room has been left for the addition of a third blower.

ping turbines still contains more than 90 per cent of the Btu in the steam leaving the boilers and all this heat is required for process and other power uses. When credited with this useful heat, efficiency of the topping steam turbine plant ranges up to 75 or 80 per cent compared to 15 to 25 per cent for a condensing steam turbine plant. These efficiencies include boiler and auxiliary losses but do not include blower efficiency, since that would be comparable for either type of driver. The inherently lower efficiency of even the modern condensing turboblower plants is due to the fact that approximately 70 per cent of the Btu in steam from the boilers is lost in the condenser circulating water.

Figure 10 shows the completed installation.

DISCUSSION

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George H. Krapf: Early in the last war we were faced with the problem of having three blowers to blow two large furnaces and not one of the blowers was large enough to blow one of the furnaces. For a while we operated with one blower on one furnace and two blowers on the other furnace. This meant that the furnace with one blower was not blown to capacity and the furnace, of course, being blown with two blowers had much more wind capacity available than it could possibly use. So, it was intriguing to think of the possibility of running the two furnaces on the three blowers with one of the three blowers split between the two furnaces. We opened up the blast valve on one of the blowers and bled wind to the furnace that was being under-blown. We had no controls on this except, of course, the inlet volumetric controls, so the wind to the two furnaces was controlled by the number of charges that the two furnaces took daily. Since the two furnaces were identical, if we kept the charges balanced, we knew that there was a reasonable split of wind. The result was a major increase in production of vitally needed iron.

As soon as feasible, flow measuring orifices were put in the blast line to each furnace and flow meters were installed at the blowing rooms.

We have in another plant, one blower blowing into a system which controls four furnaces by means of flow control valves in the blast mains to these furnaces. At the present time, this blower is blowing two furnaces, but it can blow any combination of the four furnaces, supplemented by other engines in the blowing room. A second turboblower is being installed. It will also feed into the manifold system. The controls are so arranged that the two blowers can blow four furnaces. The blowers can work in parallel, blow two furnaces each, or any combination. We are thus getting closer to true manifold blowing of the blast furnaces.

There are, of course, many facts to consider in thinking of setting up a blowing room to manifold blow a group of blast furnaces. Some of them are:

1. Continuity of operation of the furnaces is the biggest gain that can be made with such an installation. A particular furnace is no longer at the mercy of one engine.
2. It is difficult to match a blower to a blast furnace so that a blower is operating at its optimum range because blast furnace sizes do not stay put. Manifold blowing provides flexibility of blower size.
3. In many large installations there is excessive capacity in the individual blowers that could be made available by manifold blowing, thus making it unnecessary to install spare blowers.
4. The principal draw-back of manifold blowing is the fact that some pressure drop must be maintained across the control valve, and also, you must maintain pressure in the system to blow proper volume to the highest pressure furnace. This increases operating cost.

If we can dream a bit it is possible to visualize a blast furnace installation supplied by one big blast line that would circle the plant, with take-offs to each furnace, with flow control valves and control equipment at the furnace. Then the blower would have under his control the wind to each furnace. The line could be pressurized with several high capacity, high efficiency blowers, plus one or two smaller units to balance the load. This should make a system of low installation cost and reasonable efficiency.

John F. Topping: While topping turbine drive appears to be the proper economic answer for this plant, I would assume that it is not intended as the best solution for all plants, and therefore a thorough study would be made in order to determine the proper selection of equipment in each instance.

A second thought concerns split-wind blowing, the desirability of using split-wind would naturally depend on the overall economics of such an arrangement. As I understand the paper, it would appear as though some appreciable efficiency may be lost due to the requirement of maintaining a system pressure equal to the highest furnace pressure plus the necessary extra pressure for control purposes. The cost of the extra power may be more than offset by other economic items, and therefore again it would seem to me that a complete study of each plant would be required to determine whether split wind would be the answer.

L. E. Ruffing: Being located in Pittsburgh, I was in contact with this job from the time the first blower was started, until the system was in full split wind operation. Initially, the blowers were placed in service, each blowing one furnace on air volume regulation. At the start-up of the split wind blowing control, it was quite evident that sufficient foresight had been exercised in preparing the blast main piping, valving, and furnace signaling system, so as to permit any one blowing unit, or any combination of blowing units, to be, put on, taken off, or transferred from one furnace to another, without interruption or serious interference with the furnace operation.

Due to the particular operating conditions, the first split wind blowing was done with one of the new 90,000-cfm blowers, operating on discharge pressure regulation, and the 35,000-cfm bessemer blower, base loaded on air volume regulation, the larger blower feeding into the header, serving No. 2 and No. 4 blast furnace, the small blower feeding into the No. 2 furnace blast main, at a point ahead of the orifice plate and control valve. All of the regulating and checking of the furnaces was done at the No. 2 and No. 4 furnace volume control boards. Within the limit of the wind available, this operation was successful and continued for several days. Should plant operations at some time not warrant running both large blowers, this might be an economical method of operation.

Again, due to plant operating condition, we were unable to operate the full split wind system, however, both large blowers were placed on discharge pressure regulation, being parallel operated on a volume basis from the master pressure control. At this time, the air volume to No. 3 and No. 4 blast furnaces were being controlled from their respected volume control boards.

When the system was put on full split wind operation, we followed the procedure outlined by Mr. Austermiller for changing the No. 1 and No. 2 blowers from volume to discharge pressure control, thus the No. 3 and No. 4 furnaces were being blown with the split wind control. The No. 2 furnace was being blown with the 35,000-cfm blower and two vertical reciprocating engines. After the cast on No. 2 furnace, the engine speed was reduced, necessary valves opened, and the furnace volume regulator set for the desired wind. The engines were shut down, and the small turboblower taken off the line, thus, the three furnaces were being blown with the two 90,000-cfm blowers.

After a few days operation, it was decided to try the system with one of the reciprocating engines turning over on the line. Since the engines would have to be rolled periodically to clear them of condensate, it was necessary that the split wind control system function properly under these conditions. Several engines were rolled over at low speed and then one engine was brought up to an operating speed so that approximately 25 per cent of the total 170,000 cfm being blown in the system was from reciprocating engines. The system operated quite satisfactorily under these conditions. The top limit to which the reciprocating engines could be used in the system, has not been determined.

W. B. Wilson: These authors are to be commended for their presentation of a case history which indicates some of the benefits that can result from long range planning. I will confine my remarks to the steam system rather than the wind.

There are many steel mills that can realize large savings in annual operating costs by taking a step to higher initial steam conditions when existing obsolete boilers are to be replaced or when additional capacity is required.

I do not believe actual savings in operating costs attributable to the installation of the two topping turboblowers as step two of the National Works' modernization program were shown in the paper, but I am sure they were savings to be proud of. The third step, shown on Figure 2, indicates another large reduction in operating costs when a new turbine-generator is installed to generate 25,000 kw of electric power. Figure 2 indicates that all the additional steam required for this turbine-generator can be generated in central boiler house with the blast furnace gas diverted from old boiler house "L" and from boiler house "T" which were no longer required after the topping turboblowers were installed as step two in the modernization program.

Use of an automatic-extraction condensing turbine-generator gives operating flexibility to meet changed plant requirments. As the 150-psig steam, requirements are reduced by replacing the obsolete blowing engines, for instance, the turbine-generator can continue to generate its 25,000 kw at reduced throttle flow and with reduced extraction steam flow. Depending on the expected future plant requirements, the turbine-generator could be an automatic extraction-admission unit that could automatically operate to admit 150-psig steam to generate power during any period there was an excess of low pressure steam.

As pointed out by the authors, the topping turboblowers are controlled in just the same way as condensing turboblowers which most plants have in your blowing rooms. The elimination of the condenser and the circulating water, which is usually in short supply in our steel mills, is certainly a point favoring the topping turboblower where it can be fitted into the mill heat balance.

The authors mention high efficiency of the topping turboblower plant, and this is a very important item that must not be overlooked. For instance, if we consider fuel at 20¢ per million Btu ($5.00 per ton coal) the fuel chargeable to wind for blast furnaces requiring

two 10,000-hp topping turbines would be approximately $200,000 per year less than if modern condensing turboblowers were used.

John J. Alexander: Mr. Austermiller has presented a very interesting description of equipment for blast furnace blowing. It is apparent that the use of a topping turboblower with full utilization of exhaust steam can result in much lower cost of blast furnace blowing. It is unfortunate that no sketch was included to show schematically the distribution of air to blast furnaces.

From recorded data by Figures 5, 6 and 7, calculations indicate that the steam rate of the topping turboblower is 34.8 lb steam per M cu ft of air at 24-psig discharge pressure. The steam rate for blowers of similar size driven by a condensing turbine is about 13.0 lb steam per M cu ft of air at 24-psi pressure; however, the heat rate chargeable to the topping turboblower is only 4300 Btu per M cu ft air at 24-psi pressure compared to 17,000 Btu per M cu ft air charged to the turbine with condenser when delivering 90,000 cfm at 24-psi blast pressure.

Figure 9 shows that blast pressures are about 19-psig or approximately 5 psi less than the blower discharge pressure. If the 5 psi pressure drop is charged to split wind regulating devices, we can properly compare the heat rate of the topping turboblower at 90,000 cfm, 24-psi at 4300 Btu per M cu ft air with a condensing turboblower without split wind control operated at 90,000 cfm, 19 psi blast pressure which has a heat rate of approximately 15,000 Btu per M cu ft air when condenser losses are included. This comparison indicates that the cost for blast furnace blowing is reduced about 70 per cent even though losses for split wind control are charged to the topping turboblower.

Is it possible to use all exhaust steam from the topping turbine at all times with changes in furnace and steel production? A topping turboblower, if operated at 90,000 cfm at 24 psi blast pressure and exhaust steam bled to atmosphere would have a heat rate of 44,000 Btu per M cu ft or steam charge for this operation would be 2.5 times the cost of a condensing turboblower at same volume—pressure rate.

The steam consumption rate per M cu ft air delivered by the topping turboblower is increased by partial load operation more than the condensing turboblower. Apparently one or more topping turboblowers used as base load units with split wind control and condensing turboblowers, operated at partial loads, to supply all variations in wind volume to a multiple blast furnace plant, would provide a substantial reduction in the cost of blast furnace blowing if all exhaust steam is used economically. This paper by Mr. Austermiller and Mr. Smith has provided a real contribution to the development of more economical blast furnace blowing.

Has the use of split-wind blowing necessitated the change of other associated equipment such as snort valve? Has any change in casting, checking or stove practice been found necessary?

W. A. Smith: We have had no change in our blast furnace practice. I might point out it takes about 20,000 cfm at normal pressure to take the blast furnace off the line by opening the snort valve.

Edwin N. Hower: Regarding the turboblowers for a second, there are three installations of split wind blowing in Canada, which came ahead of the ones at National Tube and the South Works at Chicago. I am particularly familiar with two of these: one the Canadian Furnace Co. at Port Colborne and the other at the Steel Company of Canada at Hamilton. Those installations have both been in for several years. They are rather interesting as they present a bit more of a problem than some of these others because the capacities of the two furnaces on which the blower load is divided, are so widely divergent. At the Steel Company of Canada they have been blowing two furnaces, one of which has half the capacity of the other, and at Canadian Furnace Co., the smaller furnace of the two on split wind is less than a third of the capacity of the other and operates at a considerably lower pressure. Both installations have worked very successfully.

E. O. Austermiller: While this is not the first installation blowing split wind with blast furnace blowers, it is the first installation on the continent, and we know of none other anywhere, where topping turbines are used on blast furnace blowers. Also, all of the other split wind blowing applications have one blower blowing two furnaces and here we are blowing three furnaces with two blowers.

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Figure 1 — Presque Isle Dock, C & O Railroad, has the first adjustable voltage controlled hulett type unloaders. View shows rigid structure and operator's cab directly over bucket.

The Brains and Muscles of an Ore Bridge

By H. A. ZOLLINGER
General Mill Section
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▲ IN the last five years all the new ore yard installations except one, have been made with adjustable voltage ore bridges and unloading towers. The adjustable voltage drives have proven less overall cost and have given greater average outputs than a-c or constant potential d-c rigs. The adjustable voltage control systems have been applied to hulett unloaders, man-trolley unloaders, rope-trolley unloaders as well as ore bridges yielding excellent results.

The hulett type unloaders (Figure 1) were introduced at Lackawanna RR dock, Buffalo, N. Y., as a faster means to unload ore boats. The faster unloading was accomplished by placing the operator only a few feet over the bucket, for better visibility, and by making it a rigid structure, to overcome the problems of a swinging bucket.

The unloading towers (Figure 2) and ore bridges with their bucket suspended on two or four ropes, are of either the two-motor hoist or single-motor hoist type. The two-motor hoist is by far the most common and uses two equal size hoisting engines with the close engine opening and closing the bucket and the hold and close engines jointly hoisting and lowering the bucket. The single motor hoist uses one large hoist engine to hoist and lower the bucket and one smaller engine to open and close the bucket.

There are three basic electrical systems used on mod-

A major advantage of an adjustable voltage drive over a constant potential drive is that the operator has fewer responsibilities and the control assumes more . . . . adjustable voltage will automatically regulate to keep same speed at all rated loads, helps regulate acceleration, deceleration and torque, and will give slower speeds for positioning.

Figure 2 — Three adjustable voltage, 20-gross ton, man trolley ore unloaders at Greenwich Point Pier, South Philadelphia, are operated by the Pennsylvania Railroad. The fourth is being built.

Figure 3 — General view of McLouth Steel, 12-gross ton, man trolley shows collectors, operators cab and small control room.

ern unloading towers and ore bridges. The first, and by far the most widely used, is a 250 or 550-volt constant potential d-c system. The second is an adjustable voltage scheme with individual generators supplying power for the main drives. The third is a low or high voltage a-c system, which is almost extinct in the United States and Canada but found in Europe. With the majority of the rigs of one type of d-c, the discussion will be limited to these two d-c electrical systems.

Here only the two-motor hoist man trolley (see Figure 3) ore bridges and unloading towers for handling ore, limestone, dolomite, coal and other steel mill raw materials will be discussed. The hulett and rope-operated type rigs and the single-motor hoist drive will not be discussed, however, many portions of this paper apply directly to them.

Figure 4 — General view of a typical 250-volt, constant potential ore bridge shows absence of machinery house and shows larger trolley control house.

CONSTANT POTENTIAL D-C SYSTEM

There are approximately 200 to 300 man trolley bridges (Figure 4) and towers using this system and they are the backbone of the nation's ore handling. The use of series type mill motors, magnetic shoe brakes, magnetic controls, dynamic braking and accelerating resistors, master switches and limit switches is standard for the hold, close, trolley, turntable and bridge drives. The hold, close and turntable drives always use a series motor and more commonly a series wound brake for greater safety than the shunt brakes. Shunt brakes are used on the hold and close drives when higher brake torques are required than obtainable for series brake coils. The shunt brakes are operated by a series-wound brake relay to give similar action and safety features of the series brake. The trolley and bridge drives sometimes use a compound-wound motor and always use shunt brakes for obtaining a drift point.

The series (or compound) motors become the muscles to move the load in any direction. The magnetic control and the operator become the brains of the ore bridge. The control can sense the following:

1. The master switch has been advanced too fast on acceleration hoist.
2. The motor has carried high currents for excessive amounts of time.
3. The motor has tried to hoist or travel too far.
4. The drive has lost power.
5. The drive is overspeeding.
6. There are excessive winds.
7. Misalinement of bridge legs exists.
8. Can keep an empty bucket open on lowering.
9. Loss of motor field.

This represents about 25 per cent of the brain work of which the operator has to supply the other 75 per cent. Among his chores are the following:

1. Select the proper speeds at the unknown loads.
2. Select the proper distances to run, where to dig, and where to dump.
3. Select the proper direction.
4. Make sure he is clear of all hatches, hoppers, etc.
5. Move the largest amount of material in the least time.
6. Safety of other personnel and equipment.
7. Prevent tangling of lines.
8. Note bucket has overdug or is caught.
9. How to dump to prevent degrading, in the case of coal.
10. Keep bins and hoppers full, but not overloaded.
11. Keep a loaded bucket closed on lowering.

For years, men have been trying to invent ways to lessen the operator's brain work thus obtain greater output and greater consistency of output. It was with this in mind that adjustable voltage of the modern day concept with regulator, was first applied to an ore bridge. See Figure 5. The installation was at the Otis Works of J. & L. Steel in Cleveland, Ohio. This type of regulated, adjustable voltage control had been applied to other material handling equipment as far back as

1938, but it took a long time to convince people of its merits.

ADJUSTABLE VOLTAGE

Since the first man trolley, regulated, adjustable voltage rig was installed in 1951, 19 others have been or will be installed by the end of 1956. See Figures 6 and 7. Within this same time, only 14 constant potential man trolley ore bridges or towers have been installed with seven of the 14 all at one plant. They are different from constant potential rigs in their use of shunt wound (without series field) mill motors, a regulated magnetic control with torque limit and speed regulation, and do not use large accelerating resistors, accelerating contactors, and reversing contactors.

The use of 230-volt mill motors, which are insulated for 600 volts d-c, at above rated voltage yields higher horsepower capacities from the same frames. Modern man trolley rigs generally use voltages between 360 and 460 volts. For example, select a 618 mill motor whose continuous rating at 230 volts is 200 hp, 420 rpm and 2500 lb-ft of torque. If this motor is operated at 460 volts, neglecting Ir drop, the motor rpm will double or be 840 rpm because 460 volts is twice 230 volts. The torque rating is still 2500 because the current has not increased nor has the field strength changed. This provides an 840 rpm motor developing 2500 lb-ft of torque or 400 hp. Also, since the motor is at twice speed, the fan provides more cooling in excess of any increased losses and even greater horsepower can be produced. This increases the continuous capacity to 480 hp. By using this increase in capacity, all drive motor frame sizes for comparable constant potential rigs can be reduced by one frame size and sometimes two frame sizes with adjustable voltage drive. Along with the reduction in motor frame size, the brake size usually is reduced one frame because of the increased motor speed.

For each drive, an appropriate generator is selected to handle peak loads as well as continuous load requirement, and one motor-generator set drive motor is then chosen to handle the net horsepower requirement and the maximum possible peak requirement. The motor-generator set motor, the generator and the drive motor become the muscles of each drive.

The magnetic control and the operator again become the brains of the bridge. The major difference from constant potential is that the operator has fewer responsibilities and the control assumes more. The control senses or performs all of the functions listed for the constant potential drive, and in addition, the adjustable voltage control provides the following:

1. Regulates to keep essentially the same speed at all rated loads.
2. Senses moving the master switch too fast on acceleration and deceleration.
3. Limits the torque the motor can exert.
4. Keeps on full torque until drive has accelerated to the desired speed.
5. Lowers a full bucket without opening the bucket and without manipulating the master switches.
6. Provides equal retarding torque as compared to accelerating torque.
7. Slower speeds at all loads for positioning.
8. Load sharing on hoisting or between two trolley motors at all times.
9. Keeps brakes released until electrical braking has

Figure 5 — First adjustable voltage ore bridge and still rated one of the largest in the country is that built for Otis Works of J & L Steel Co.

Figure 6 — One of the most modern ore bridges in North America with the hold, close, trolley, bridge, and apron hoist drives, all powered by adjustable voltage, is that built for the McLouth Steel Corp.

Figure 7 — View inside McLouth Steel's machinery house of synchronous motor-generator set shows from right to left, trolley generator (rated 400 kw), motor-generator set motor (rated 700 hp, 350 rpt), hold generator (rated 200 kw), close generator (rated 200 kw) and constant potential exciter (rated 50 kw).

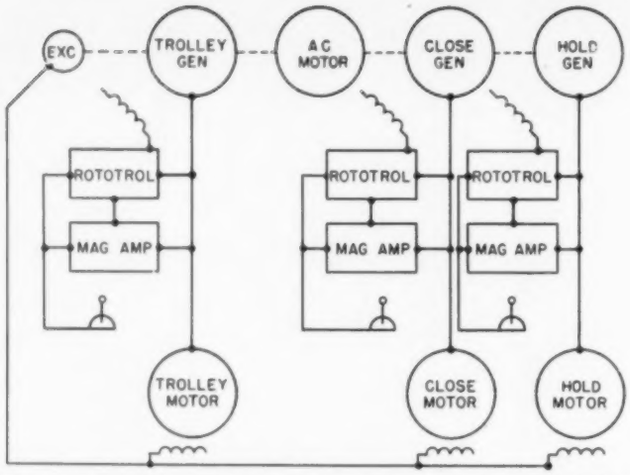


Figure 8 — Schematic layout of three main adjustable voltage drives using rotating regulators and magnetic amplifiers.

reduced speed to 10 per cent which means brakes only do 1 per cent of the braking.

This is about 50 per cent of the brain work. This control has taken twice the responsibility as did the constant potential control and has materially reduced the amount done by the operator. This means less operator fatigue and by experience, shows a higher average digging rate.

To obtain some of the previously mentioned control features, a regulator is used. The system we have found most successful is to use a magnetic amplifier for torque limit and rotating regulator for speed regulation. The principal use is to compare various signals such as voltage, current and master switch positions independently on an iron core, to obtain a proportional output. These signals are carried through independent fields to the iron core of the magnetic amplifier and/or the rotating regulator and by algebraically summing the field strengths on each core, the desired output is obtained in motor speed and motor torque. This method of matching signals affords easy detection of grounds because all circuits are isolated.

The magnetic amplifiers serve to override the rotating regulator to limit the motor current or torque to a predetermined value. See Figure 9. The rotating regulator is in charge of keeping the speed relatively constant over the load range, setting the direction for the generator voltage to build up, which in turn provides the proper motor rotation, to force the generator to keep a constant acceleration rate, and to keep the bucket open or closed at the respective times.

The magnetic amplifiers are used to provide static type apparatus, i.e. no moving parts for greater reliability, and for their high speed of response. The rotating regulator is used to obtain a reversible output, faster speed of response of drive motor, and still keep the same conventional design as the main drive generators for ease of maintenance.

It is customary that two motors be applied in parallel to drive the trolley thus reducing the chance of wheel slippage (over-driving on axle) and to keep the advantage of higher horsepower at over-rated voltage (as would be lost if they were connected in series). This, however, requires some means of load sharing, whether by a drooping resistor or by regulated field trimming. Our system uses a small rotating regulator to adjust the motor field strengths with respect to each other and has resulted in excellent performance. See Figure 10. The circuitry is such that if motor A tries to take greater load than B, its motor field is strengthened and motor B's field is weakened. With the fundamental relationship of increasing the motor field strength to reduce the motor speed, it can be seen that motor A will slow down and give up the increase in load, and motor B will speed up and assume its share of the load.

Another scheme to obtain positive load sharing is to use two generators and two motors in a sandwich scheme, i.e., one generator, one motor, one generator and one motor in series. This eliminates any resistors or load sharing rotating regulator but adds two power collectors between the structure and the trolley and two half-size generators to replace one full-size generator.

The two basic electrical schemes have been presented. A comparison of the more important features will help a user choose the proper type electrical drive for his application. Some of these considerations are next discussed.

Figure 9 — Upper right hand trace shows ideal current limit on accelerate hoist and lower right hand trace shows constant acceleration rate up to full speed.

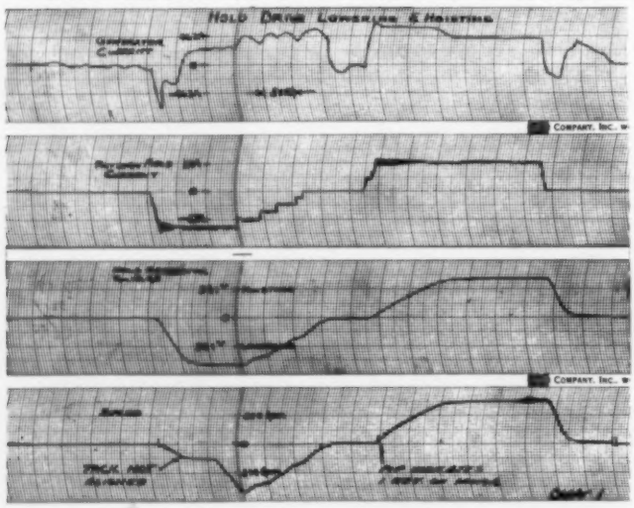
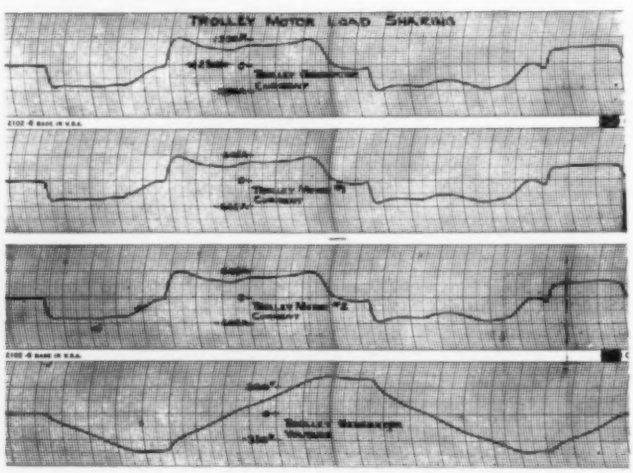


Figure 10 — Load sharing is shown between trolley motors in parallel under acceleration and plugging conditions. A load balance rotating regulator was used to obtain desired load sharing.



POWER SUPPLY

First the power supply required for each type of rig should be considered. The adjustable voltage rig would require high and low voltage switchgear and a transformer mounted at the nearest substation to reduce the high voltage distribution system to 4160 or 2300 volts or lower in some exceptional cases. A 10-ton rig, which requires about a 600-hp, motor-generator set, would require suitable equipment back at the substation costing about $30,000. Now compare this to a 10-ton constant potential rig; that would require a rectifier, switchgear, a loading resistor for absorbing any pump-back energy and associated resistor control. A recent study showed this to cost about $85,000 or about three times the adjustable voltage substation equipment.

RECONNECTING EQUIPMENT

With adjustable voltage, some of the existing equip- for the main drives can be used as portions of the auxiliary drives. Take, for instance, a trolley generator and its adjustable voltage control and use them for operating the tower or bridge drive. This means that only bridge motors, brakes, one or two transfer contactors, a few control relays, and a selector switch have to be supplied for the bridge drive. This nets a saving in initial expense, a saving in space and weight, and provides a smooth operating bridge drive. The bridge drive would not normally be adjustable voltage because the infrequent operation would not justify the extra expense for an independent adjustable voltage drive.

Using this idea on another ore bridge, the hold and close generators and associated control were reconnected to the pier and shear leg drives respectively, thereby providing an easy means of operating the legs independently, as well as operating them together with an absolute means of skew control. On other occasions, the apron hoist drive has been made adjustable voltage by using one of the existing generators and associated control.

When trying to reconnect constant potential control, the problem becomes more involved because the motor sizes may not be anywhere near equal, and the accelerating resistors would not provide the proper torque. The end result is that on constant potential rigs, each drive has its own separate control and resistors.

OPERATOR FATIGUE

Another important feature in comparing the type of electrical drive to buy is operator fatigue. On two rigs of comparable output, one adjustable voltage and one constant potential, the operator will definitely notice his kidneys and back are more tired after working the constant potential rig as compared to the adjustable voltage rig. This is brought upon by several factors, the first being that on acceleration of the trolley, the constant potential rig has a higher initial acceleration rate or starting shock, and a much less final acceleration rate where the adjustable voltage has an average accelerating rate held constant through acceleration. The second is that with adjustable voltage, the motor torque builds up much more smoothly and over a longer period of time than the constant potential d-c. This does not mean, however, that the adjustable voltage control is sluggish, because the rate of rise of current to current limit is less than 0.3 sec; the constant potential being almost instantaneous. The third factor is important when an operator is trying to position his bucket over a transfer car, a railroad car, a hatch or some other piece of equipment. He does not have to keep manipulating the master switch to get his desired speed. He knows from experience that with adjustable voltage, he gets the same speed irrespective of load, but with the constant potential schemes he has to adjust his master switch for the load.

COLLECTORS

A word or two should be mentioned about the collector systems. Constant potential rigs use less collectors than the adjustable voltage rigs. For discussion, let us break these collector systems down into the primary system which feeds onto the bridge, and the secondary system which feeds onto or off the trolley.

The primary system of a constant potential bridge uses two collectors and the adjustable voltage system uses three collectors of smaller cross-section. Steel and aluminum are used for the collectors and many different materials, such as, steel, cast iron, bronze, carbon, and graphite are used singularly or together for the shoes. For the constant potential system, a steel collector requires a copper backup cable or feeder cable where the aluminum probably will not require a backup cable for the 250-volt, d-c supply. The use of aluminum with an adjustable voltage system for the 2400 or 4160-volt a-c supply does not require any copper backup (see Figure 11) and generally the use of steel for the service does not either. The cost for a 3000-amp, 250-volt, steel, constant potential system or a 500-amp, 2400-volt, aluminum, adjustable voltage system, each enclosed, 1000 ft long, and overhead is in favor of the adjustable voltage aluminum system by $38 per ft of system to $44 per ft of system. Of these, $10 per ft is

Figure 11 — A typical installation of 2300-volt, a-c primary collector system for an ore bridge or tower. Aluminum collectors were used without copper backup cable.

for the enclosure. The aluminum system has one further advantage in that the installation costs for aluminum are half what they are for steel.

As far as can be determined since 1952, aluminum has been applied to all ore bridge and tower installations on either the primary or secondary system.

The secondary collector system for the constant potential drives uses two collectors for the incoming 250-volt, d-c and six for operation of the bridge from the trolley. Of the six for the bridge, three are power collectors and three are control collectors. This makes a total of eight for the constant potential rig. The adjustable voltage rig can use as few as nine, as high as 19, but more commonly uses 13. On one system without a-c on the trolley, eight of the 13 are power collectors, i.e., two for the hold, two for the close, two for the trolley, and two for the constant potential d-c. Three of the control collectors are for control of the hold, close and trolley drives, and two others are used for auxiliary devices, such as for transfering a generator and control to another drive operation of the rail clamps, and emergency stop. A second system with a-c on the trolley uses five d-c collectors of the 13, i.e. one for the hold, one for the close, one for the trolley, one for the constant potential, and one for a common return of all four drives. Three collectors are a-c power collectors, and the remaining five are control collectors with the same functions as before.

The cost of the secondary system is included in the builder's price, and for adjustable voltage would increase his price by less than 1 per cent over the constant potential system.

ROPE WEAR

Another large factor in maintaining an ore bridge or an unloading tower is the rope wear. Through experience with adjustable voltage and constant potential rigs, it has been shown that almost twice the rope life can be obtained with an adjustable voltage rig that can be obtained from a constant potential rig. This is based on good operators who let the bucket "lay over" a minimum number of times. Two reasons for this are: there is less maximum stress for the same average acceleration rate, and there is a more gradual build-up of line pull which reduces the tendency to snap and break the ropes rather than actually wear them out.

ROPE SIZE

For an idea of comparison of rope size and stress, a constant potential, 15-gross ton rig, with 325 fpm on the hoist motion, uses four 1¼-in. diam heavy plow steel ropes with a static factor of safety of 3.2 on the peaks. A comparable adjustable voltage 15-gross ton, 325-fpm rig uses the same diameter ropes, but provides a static factor of safety of 4.3 on the peaks. These peaks are figured without bucket swing and inertia effect. The inertia effect and effect of bucket swing would tend to decrease the factor of safety. After adjusting for inertia and bucket swing the factors of safety become 1.33 and 1.8 for constant potential and adjustable voltage drives respectively and the adjustable voltage drive remains ahead.

As well as the rope stresses, there are definitely different stresses in the gearings. The constant potential rigs impose about 15 per cent higher shock loading on the gearing. When considering only the motor, brake and gearing, the adjustable voltage drives do lose some of their dollar-wise advantage gained with the smaller motor and brake, in the gearing. This is because the overall gear ratios for adjustable voltage drives are about twice as great as for constant potential drives. Quite often though on existing designs, one part of line has been used for the hold and close drives. The bridge builder would then for the adjustable voltage drives, keep the same gear ratio, and design the drive for two parts of line on each the hold and close drives.

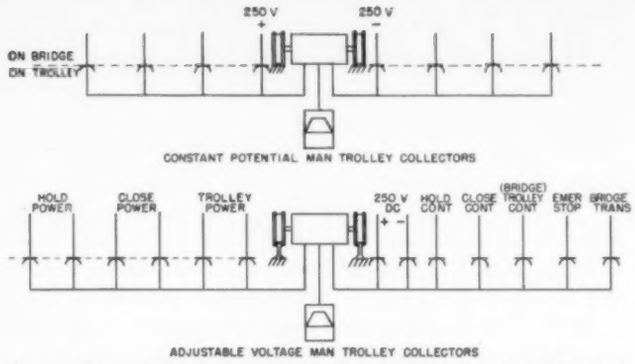


Figure 12 — A typical layout of secondary (or trolley) collectors for constant potential and adjustable voltage man trolley.

STRUCTURE

Theoretically, the adjustable voltage control would allow the bridge builder to use less steel because he can rely on a certain peak torque being exerted on adjustable voltage where he cannot with a constant potential drive. This is again offset by shock loads due to motor inertia. The practical answer is that bridge builders try to use existing bridge designs which result in approximately the same amount of steel in either case.

One disadvantage to the adjustable voltage drive is that it requires a house to enclose the motor-generator set, switchgear, and control. This disadvantage on the bridge structure is offset by the advantages gained on the trolley, in that the trolley house can be smaller, 1100 cu ft to 450 cu ft, and weight of electrical apparatus is less. One case showed 47,435 lb for a constant potential rig and 28,335 lb for an adjustable voltage rig.

INSTALLATION AND START-UP

Installation and start-up is an important part, along with these other considerations. Quite often at the time of installation and start-up, pressure is exerted to get going, and because the electrical equipment is usually the last to be checked out, it is charged with holding up the entire project. With this in mind, the electrical manufacturer goes overboard to get the rig operating. On a constant potential rig, you have less wiring but it is heavy and cumbersome to work with. Less time is actually required for adjustment in the constant potential control, but again because the control is doing less for you. The adjustable voltage control requires more supervision at start-up because the regulators have to be tuned. The adjustable voltage system is

easier to adjust, though, because of the smaller wires and cable and the omission of the large accelerating resistors. Usually an adjustable voltage ore bridge will take three days longer for electrical start-up.

One further point is the ability to make changes in operating speeds at the time of starting up. The adjustable voltage system is more flexible and changes in speed can be accomplished easily, whereas they cannot be made with a constant potential rig without changing the gear ratio.

COMPARISON OF TROLLEY OUTPUT

In Figure 13 the horizontal axis represents draw bar pull at the trolley in the two respective directions of "In" and "Out." The vertical axis shows speed in feet per minute for "In" and "Out" travel. The dashed line curve in the upper right quadrant is the full speed accelerating curve and the dashed line in the upper left quadrant is the decelerating or plugging curve. These curves are for two 616 series-wound mill motors operating with a constant potential control. On a duty cycle basis of equal motor heating and 86 ft of travel each way, the two 616 motors will only provide the rig output as shown by the curves representing two 612 shunt wound motors with adjustable voltage control. The two 612 curves show the right hand vertical curve as the accelerating pull coming "IN" and the left hand vertical curve as the decelerating pull coming "IN."

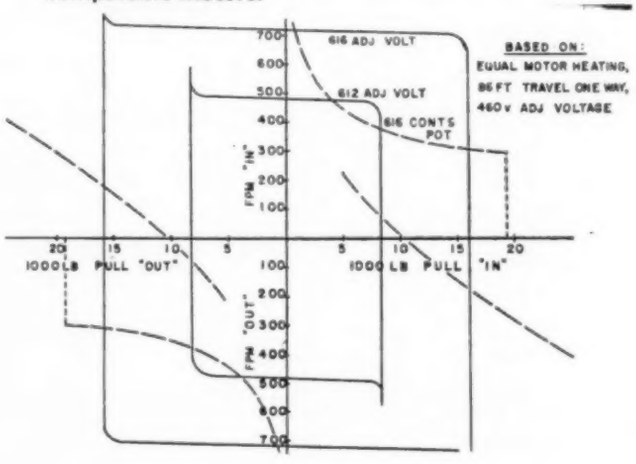
If two 616 shunt mill motors were used with an adjustable voltage control, the trolley output can be increased by 50 per cent. Taking into consideration that the hold and close drive operating times are not changed, the actual tower or bridge output in tons per hour would be increased by 20 to 25 per cent. This is quite an increase.

POWER CONSUMPTION AND PEAKS

Most steel mills are not concerned with the amount of power used and power peaks, but operating docks are. The motor-generator set of the adjustable voltage scheme acts to cut down power peaks. For instance, on a constant potential rig with the hold and close drives accelerating and the trolley decelerating by plugging, the line would supply positive power to all three motions. If in this same case, adjustable voltage were used, the trolley when decelerating would pump energy back into the system, and the line or motor-generator set drive motor would supply only the difference between the power hold and close were absorbing, and what the trolley was pumping back.

As to the power used, it can be seen that the constant potential drive on acceleration uses the kilowatts calculated by multiplying full voltage times the motor current. The adjustable voltage control uses only the kilowatts calculated by multiplying the current times ½ full voltage, because the voltage varies between zero and the full voltage. This means about half the power is used with an adjustable voltage rig, that is used with a constant potential rig, in kwhr per ton of material moved. Calculation of the entire duty cycle actually shows about 0.6 as the ratio of power used, in favor of the adjustable voltage rig.

Figure 13 — Comparison of speed-load curves for a constant potential trolley and two adjustable voltage trolleys. One shows comparable output and one shows comparable motors.



DIFFERENCE IN ADJUSTABLE VOLTAGE SYSTEM

Two different systems are distinguished by the location of the regulators. These two systems are: (1) to place the regulators in the machinery house, adjacent to their generators, and (2) to place the regulators on the trolley and have the collector system between the regulator and their generators. The advantages of having the regulator on the trolley are:

1. It is easier on installation to run telephones or speaking tube between the cab and the control room right above than it is to run a telephone from the cab up to the machinery house.

The advantages of the regulator being in the machinery house are:

1. Less weight on the trolley, about 3000 lb of electrical apparatus.
2. Less space on a trolley, i.e. 70 sq ft less which almost cuts the trolley room size in half.
3. Fewer total number of contactors and relays to be maintained and mounted in either the trolley or the machinery house.
4. Lesser chance of having start across regulator output thus not requiring fused regulator output.
5. There is a higher average voltage on the control collector through acceleration, which is very helpful in breaking down oxides that build up on the collectors. With this system, the voltage goes to the highest value and stays there when the master switch is moved from zero to the full position.
6. If a collector shoe should come off, as will happen, the drive comes to a controlled stop, that is, the regulator sees nothing different than if the operator had centered his master switch.
7. If a short across the control collector and a higher potential should happen, the drive would accelerate to full speed with a normal current limit. The operator would then note this and press the emergency stop button.

The disadvantages of having the regulating equipment on the trolley are:

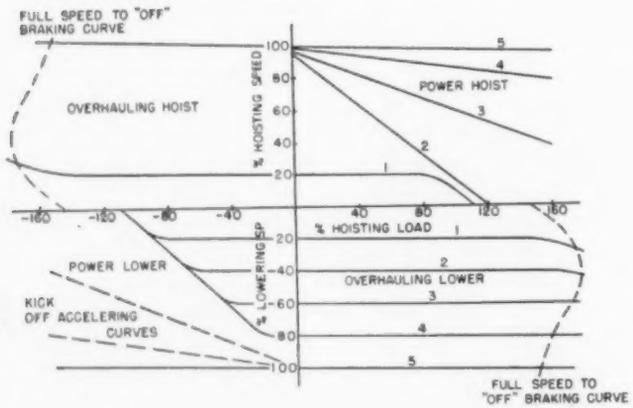
1. Adds weight, about 3000 electrical pounds.
2. Adds space, about doubles trolley control room size.
3. Increases total number of contactors and relays.
4. Requires fuses in regulator output because of the

Figure 14 — General view shows east coast sugar unloader operated remotely by "arm chair" stevedore at right.

chance of shorts. This makes less reliable regulator performance and requires greater interlocking to overcome it.

5. The voltage on the control collector rises directly with the speed of the drive which means that at times there is very little voltage on the collector to overcome any of the oxide conditions.
6. If a control collector should open, or the shoe come off, it would cause a high current and possible damage to the motor and generator. This would result in abrupt deceleration, possibly throwing the bucket into the operator's cab on the return swing.
7. If the control collector shorted to a higher potential collector, the generator voltage would increase above even top speed value, and excessive currents would be circulated in accelerating to this higher speed. Again, there is chance of damage to the generator and motor.

Figure 15 — Typical speed-load curves are given for bucket type reactor control used for heavy material handling units designed for less motor, brake, control and mechanical maintenance.



From the previous information presented, the regulator connected directly to its appropriate generator is the more reliable and a safer system.

Some day the man trolley rigs discussed are going to become "manless trolley rigs." See Figure 14. The hulett unloaders were the first step to getting the operator "down at the pile," but someone in the near future will have the foresight to put the operator down on the deck of the boat and remotely control the trolley and bucket. Also, with recent advances in speed control of a-c motors, we will see more drives using a-c motors and control. Before this change to a-c gathers much momentum, the a-c motor manufacturers will have to build a motor comparable to the d-c mill motor in performance, stamina and low inertia.

The discussion has hit upon only a few of the many features and talking points concerning the two d-c electrical systems. From experience, however, these previously mentioned points are the ones most often raised and usually are the ones considered important enough to affect the initial decision of using constant potential d-c or adjustable voltage drives.

DISCUSSION

PRESENTED BY

H. A. ZOLLINGER, General Mill Section, Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

Member: Mr. Zollinger, you mentioned recent advances in speed control of a-c motors will lead to the use of more a-c drives on gantry cranes, ore bridges and unloading towers. What are these advances you referred to?

H. A. Zollinger: Our company will soon be installing, in a large steel mill, the electrical apparatus for two, double trolley, gantry cranes. One trolley has a 4-cu yd clam shell type bucket for 24-hr duty cycle operation and the other has two hooks, a 60-ton and a 15-ton for handling a slag pot, a magnet, and a skullcracker.

All hoist controls are of the full magnetic, reversing, without load-detector, primary saturable reactor type controllers, each for use with one 125-hp, 710-rpm, 220-volt, 3-phase, 25-cycle, 50 C rise, 1 hr rated, dripproof, 275 per cent pot., wound rotor motor. This control (see Figure 15) provides the following features over and above any other a-c or constant potential d-c control:

1. No primary reversing contactors.
2. No mechanical or electrical load brake.
3. Only two accelerating contactors provide five speed points.

4. Only two accelerating relays instead of four.
5. First four of the five lowering points without operating any accelerating contactors.
6. Forces motor to do 95 per cent of all braking.
7. Smooth acceleration and deceleration comparable to adjustable voltage.
8. Five point control limits peak torques to better than conventional seven point control.
9. Can float a load with the motor and without setting the brakes.

Other features of this a-c reactor type of drive are: the drive uses standard wound rotor motors for crane and hoist service, d-c shunt wound magnetic shoe brakes, does not use any rotating regulator, costs less than an adjustable voltage drive, a nearly constant inherent decelerating torque in each direction, regenerative braking at full speed lower, power down at slow speeds, flat speed-load curves in all lowering points and the first and fifth hoisting points, infinite number of speed points between the first point in each direction and "off" for easier spotting and less motor heating than a-c dynamic braking, electrical load brake, or mechanical load brake control schemes.

All the previously mentioned features are further augmented by the reduced motor, brake, control, and mechanical maintenance. The motor maintenance is lessened first because the torque changes in the motor are smooth but not sluggish, and second the commutator and attendant brushes have been eliminated.

The brake maintenance is kept to a minimum because the motor does almost all the normal braking and the shoe brake is only used for holding the load or in an emergency.

The control maintenance is almost eliminated because of no reversing primary contactors, less accelerating contactors and relays, and what accelerating contactors and relays there are, operate less than half the number of times they would if operating in a conventional a-c or d-c constant potential control.

The reduced machine maintenance will be realized in greater rope life and longer gearing life because of smoother accelerations and decelerations.

These features have been proven on over 100 existing installations and drives have been engineered for ¼ to 300 hp at 60 cycles.

CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

Monday, October 29, 1956 — Social Hour 6:30 P.M.

Dinner 7:00 P.M. Meeting 8:00 P.M.

"Methods of Generating Nuclear Power," by C. E. Klotz, Reactor Engineer, Allis-Chalmers Manufacturing Co., Milwaukee, Wisc.

Thomas Jefferson Hotel, Birmingham, Ala.

BUFFALO SECTION

Data Not available

CHICAGO SECTION

No October Meeting

CLEVELAND SECTION

Data Not Available

DETROIT SECTION

Data Not Available

LOS ANGELES SECTION

Data Not Available

PHILADELPHIA SECTION

No October Meeting

PITTSBURGH SECTION

No October Meeting

ST. LOUIS SECTION

Data Not Available

SAN FRANCISCO SECTION

Data Not Available

YOUNGSTOWN SECTION

Monday, October 29, 1956 — Social Hour 6:00 P.M.

Dinner 7:00 P.M., Meeting 8:00 P.M.

"Brass Hats" Night
Speaker to be announced later

Mahoning Country Club, Girard, Ohio

Maintenance and Development of the Small Tonnage Steel Plant

. . . . an integrated maintenance development program improves operations and permits growth in the small steel plant . . . . necessary are adequate time, careful planning, and diligent cooperation. . . . mechanical and electrical delays have been cut practically in half in five years through such a program at the author's plant . . . .

By R. D. BRADLEY
Chief Engineer
and
D. W. PETTY, JR.
Superintendent
Electrical and Mechanical Maintenance
Bethlehem Pacific Coast Steel Corp.
San Francisco, Calif

▲ A WELL planned and coordinated program of maintenance and development will benefit present operation and will provide for the future growth of the small tonnage steel plant. It can provide effective maintenance, increased production, expanded product range, and improved quality of finished materials at a minimum cost. To be successful, such a program requires the complete cooperation of the operating and service departments.

In order to present a picture of the program now in force at the South San Francisco plant of Bethlehem Pacific Steel Corp., it may be interesting to relate a few of the historical events affecting the origin and development of the plant. As a result of the demolition and rebuilding of San Francisco after the 1906 fire and earthquake, a large quantity of iron and steel scrap was accumulated in South San Francisco, at what is now the Bethlehem Pacific Coast Steel Corp. property. This scrap provided the principal raw material necessary for the establishment of a small cold metal steel plant to supply reinforcing bar for an expanding San Francisco market.

The construction of the plant began in 1911. The main facilities installed were two hand-charged, 35-ton open hearth furnaces and one rolling mill which was driven by a used steam engine. The equipment was housed in wood frame buildings. This plant went into production as the Pacific Coast Steel Co. with the tapping of the first heat on January 2, 1912.

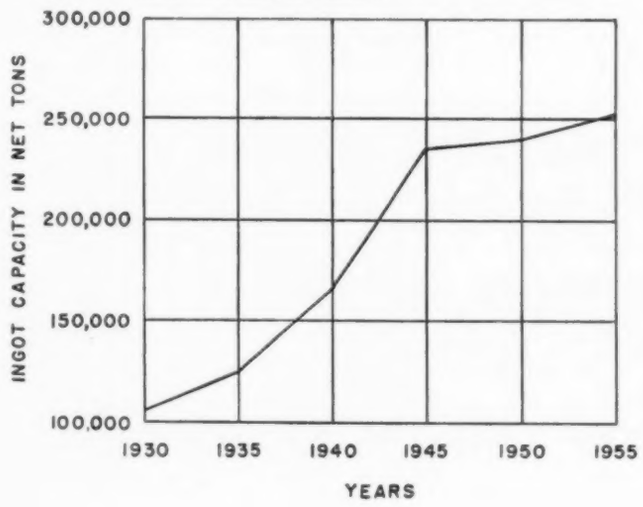
Between 1915 and 1920, the single steam driven mill was converted to electric power, and 18-in., 10-in., and 9-in. finishing mills were added. Later the 10-in. mill was changed to a 12-in. mill of the Belgian design.

In 1930, this plant along with similar plants in Los Angeles and Seattle was acquired by the Bethlehem Steel Co., and in 1945, it became a part of Bethlehem Pacific Coast Steel Corp.

Under Bethlehem management, the South San Francisco plant has been expanded to the present annual rated ingot capacity of 252,000 net tons. As illustrated by Figure 1, this increase in capacity has been achieved, gradually, over a long period of time. The original open hearth furnaces have been replaced by five 75-ton units, and ingot size has been increased to 13 x 13 in. In order to utilize the additional ingot size and production, the billet mill was enlarged to 24 in. and the rate of production of the finishing mills was increased correspondingly.

In the early days, because of limited working capital and the difficulties in acquiring funds for expansion, new development work was in a large measure accomplished through the maintenance program. This practice required that plant personnel repair all damaged

Figure 1 — Ingot capacity of Bethlehem's South Pacific plant is now over 250,000 tons.



machinery and design, build, and install all new equipment. It was not unusual, in order to improve and expand existing facilities, to purchase and rebuild used equipment such as mills, cranes, and shears. This method of development did not, of course, provide the most modern equipment which would minimize maintenance work. However, it did allow the plant to expand its production and range of products at a minimum initial cost. As a result, the plant personnel developed self-reliance and ingenuity in coping with the problems of maintenance and new development.

This twofold use of maintenance personnel that was mandatory in the early development of the plant is still highly desirable and is still in force; however, it has been somewhat formalized.

In order to apply a concerted effort to the expansion and development of any production operation, an overall plan must be evolved and followed. Such a plan must necessarily be a coordinated project embracing all phases of the operation. It is a function of the plant engineering department to act as coordinator of such a plan and to insure the conformation of each project to this development program.

It is in the planning stage of this overall program that the first combination of development and maintenance occurs. At a series of informal meetings with the departments involved, the proposed project is studied with the thought of incorporating it into the maintenance plans insofar as the manufacture and installation are concerned.

The actual engineering of a project is accomplished in the plant engineering department. The design of a "home produced" unit must conform with the machine tools available for fabrication and installation, and must make use of as many standardized spare parts as is practicable. By working in close contact with the maintenance shops, much time and money can be saved by the application of the aforementioned practices.

Figure 2 — Ingenious use of laminated steel plates for the pinion housing permitted rolling of larger sections.

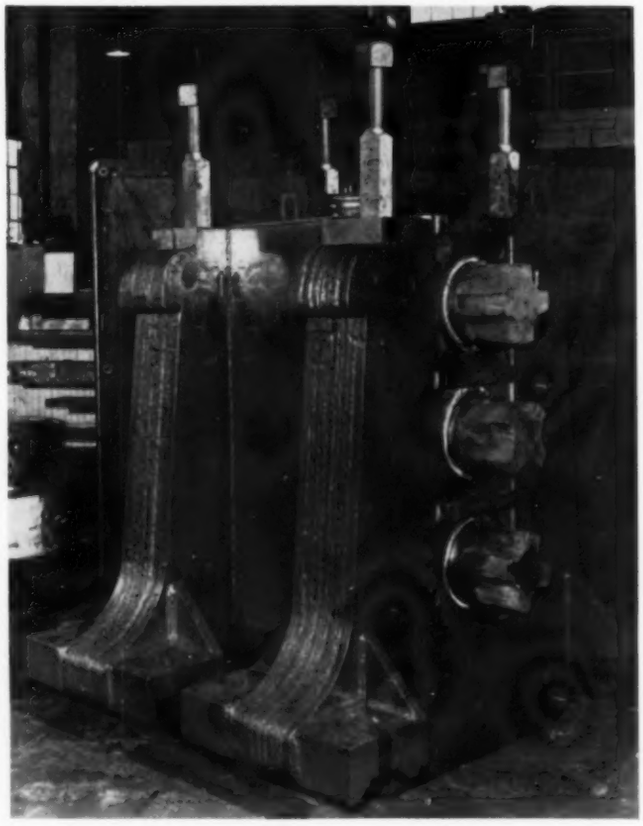


Figure 3 — A 50-ton furnace was rebuilt to 75-tons capacity at a minimum of capital expense.

At the conclusion of the formal engineering and detailing, a construction schedule is determined to facilitate the following:

1. The manufacture of the unit without interference with the maintenance schedules.
2. The installation of the unit without interference with production schedules and commitments.

Thus, it may be seen that the utmost in interdepartmental cooperation is required to attain a fully integrated development and maintenance program.

When discussing beneficial systems and procedures, as related to maintenance and development, it is vitally necessary to consider the economics involved. Of necessity, the development and expansion of production facilities requires additional capital investment. It is the purpose of this paper to illustrate how, through the integration of the maintenance and development functions, a small tonnage steel plant can be expanded according to an organized and progressive plan with a minimum capital outlay. If money is to be conserved and yet development is to progress according to schedule, such capital as is to be expended must accomplish a maximum amount of good. It will be shown that a small capital expenditure, coupled with good planning, well-organized maintenance, and a reasonable schedule, will make this goal a reality.

Major projects originate as a result of requirements for greater production, improved product quality, new product ranges, or the improvement of the efficiency of existing operations. The following three examples will illustrate several ways in which capital has been combined with repair and maintenance to effect such plant betterments:

Figure 2 shows a 16-in. mill pinion housing fabricated of laminated steel plates. This unit was built to replace an existing cast iron housing which had failed, but which had been kept in service by temporary repairs. The new housing, being stronger, permits the rolling of larger sections. The accomplishment in this instance was the combination of a necessary repair with an in-

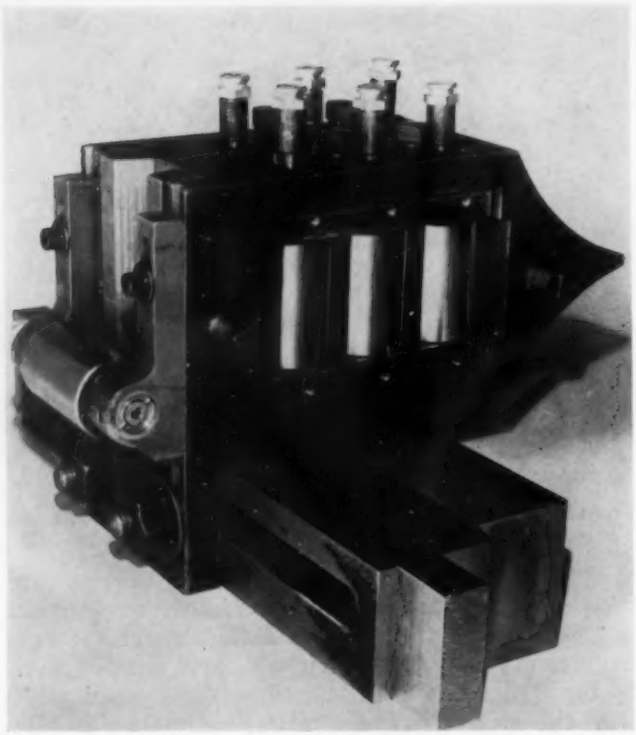


Figure 4 — Rebuilt roller entry guide gave better product quality.

crease in capacity consistent with the long range development program of the plant.

Figure 3 is a picture of a rebuilt and enlarged 75-ton open hearth furnace. The impetus for the development of this project was twofold, as follows:

1. The productivity of the old 50-ton furnace was below the shop average.
2. Repairs and maintenance were increasing due to the complete distortion of the furnace binding and pan.

This job illustrates how an increase in production may be realized with a relatively small expenditure over and above that required for inevitable repairs.

Figure 4 depicts a roller entry guide for the 9-in. mill. The stimulation for this project originated in the metallurgical department with the desire to remove minor guide scratches from some products. It was determined by the mill department and the roll shop that the answer to this problem was a roller guide. The end result is a carbon steel roller sprayed with an abrasion resistant metallic coating machined to a bright finish. In addition to improving product quality through the elimination of guide scratches, the roller guides have reduced maintenance in that one guide is adjustable for several sizes and life has been increased threefold over the old type of friction guide.

The foregoing have shown that it is often possible to have maintenance function in the best interests of development and expansion. Actually, since economics are being discussed, the time element must also be examined. Two classes of time are of primary interest:

1. The breakdown delay time of production units.
2. The time required for routine maintenance and new development work.

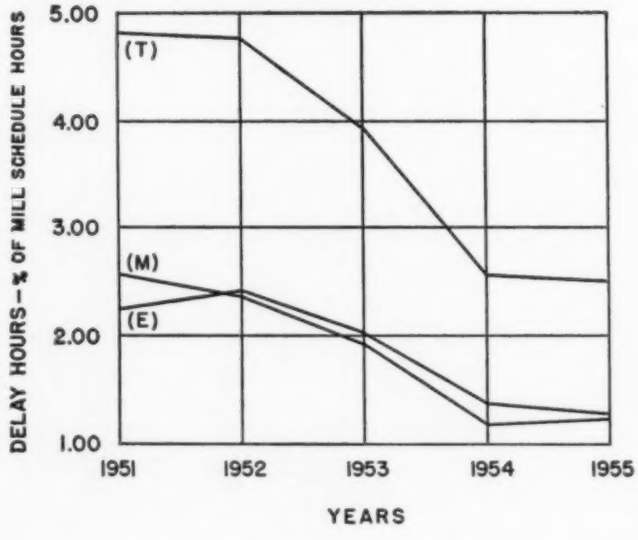
Time allocated to mill operation must be devoted to the production of the scheduled product; otherwise, overhead expenses reach a point that make continued operation unprofitable. Delay time resulting from mechanical or electrical breakdowns of equipment is one of the major controllable factors influencing the production schedule. A decrease in maintenance delay time will result in an immediate increase in the production rate of the manufacturing unit under consideration, and a corresponding decrease in the unit cost of the product. In addition, if management can obtain a specified amount of product in a given period of time, such time may then be utilized to the greatest advantage. Since the primary function of a maintenance department is the elimination of these delays, it is well to examine the record at this point to determine how successfully a maintenance program may be performed when combined with development work. Figure 5 illustrates the results of a concerted and intensified maintenance effort. Through the application of a combined maintenance and development schedule, to be discussed below, mill mechanical and electrical delay time has decreased approximately 48 per cent in the past five years.

One of the most obvious ways to reduce delays due to equipment failure is to initiate and persist in an intensive inspection and repair program. Since the normal procedure in a small tonnage steel mill is to operate all producing units at a maximum schedule, there is little time for the application of a preventive maintenance and repair program. This inherent condition creates a problem, the solution of which enables the maintenance and development programs to function as one.

Since breakdowns are to be minimized by an intensive maintenance program applied during scheduled down time, it is apparent that there must be a proper application of available manpower to cover all units. The operating units are divided into natural areas of inspection, be it either mechanical or electrical, which can be covered by one man in eight hours. When the inspector encounters a repair condition that cannot be rectified in the time alloted, the foreman is contacted and he determines the maintenance procedure to be followed.

A program such as this is dependent upon a continuing supply of highly qualified repairmen. To meet this

Figure 5 — Mill mechanical and electrical delays have been cut in half in the past 5 years.



need, a policy of "grow your own" has been developed. An attempt is made to hire high school graduates whose previous training has indicated some mechanical abilities. These new men work as helpers both in the shop and on repair work in the mills. As the training progresses, the helpers are thoroughly indoctrinated in the plant housekeeping program and are guided in the formation of safe work habits. By the time these men become qualified mechanics, they have an intimate knowledge of the producing equipment and of the maximum working loads to which this equipment will be subjected.

This program of maintenance necessitates an organized system of supplying spare parts for the replacement of worn or damaged portions of the production units. The repairman plays an important role in this program. During his inspection he determines the repair parts that will be needed at the next down period, usually the following week. These parts, if not in inventory, will be fabricated during the coming week. The first portion of each week is devoted to rebuilding and manufacturing those elements that were removed from the spare part inventory the previous weekend. This work, of course, does not occupy the full time of the entire force; therefore, the remainder of the week is spent working on development projects.

Thus, it can be seen that the highly skilled force required for scheduled concentrated maintenance also furnishes the manpower to economically manufacture equipment and material associated with the development and expansion program. Figure 6 shows an accumulation of conveyor rolls and gear cases manufactured under such a system. The making of parts such as these is accomplished as time permits. When the parts are completed, they are stockpiled until a sufficient number are on hand to start assembly or installation of the equipment.

It has been demonstrated by the foregoing that a maintenance program can be operated so as to minimize delays, and, at the same time, provide manpower to accomplish projects associated with a progressive plan of expansion. The following series of figures, showing the installation of a typical project, will illustrate the scope and magnitude that such a program can embrace. The installation under consideration is a new mechanical hotbed for the 18-in mill. Figure 7 shows the cooling bed frame preassembled with all mechanical parts connected. This preliminary assembly was accomplished by maintenance mechanics between scheduled repair jobs. The mechanics who manufactured the component parts also preassembled the bed, and later installed it. Before being dismantled and removed to the permanent site, the entire bed was operated, and all pieces were match-marked for ease of reassembling. This procedure furnishes a repair force with an intimate knowledge of the equipment in use.

Figure 8 shows the placement of foundation forms, reinforcing steel, and anchor bolts. These forms and the reinforcing steel cages were prefabricated before the excavation was started. This form work was done by the maintenance carpenters and riggers who are primarily employed for the setting of centers for the brickmasons and other furnace repair work.

Figure 9 shows the various stages of the installation.

Figure 6 — Conveyor rolls and gear casings needed for expansion programs were manufactured by maintenance department in slack periods.

Figure 7 — Preassembly helps in minimizing installation time.

Figure 8 — Forms in reinforcing steel cages were prefabricated before excavation.

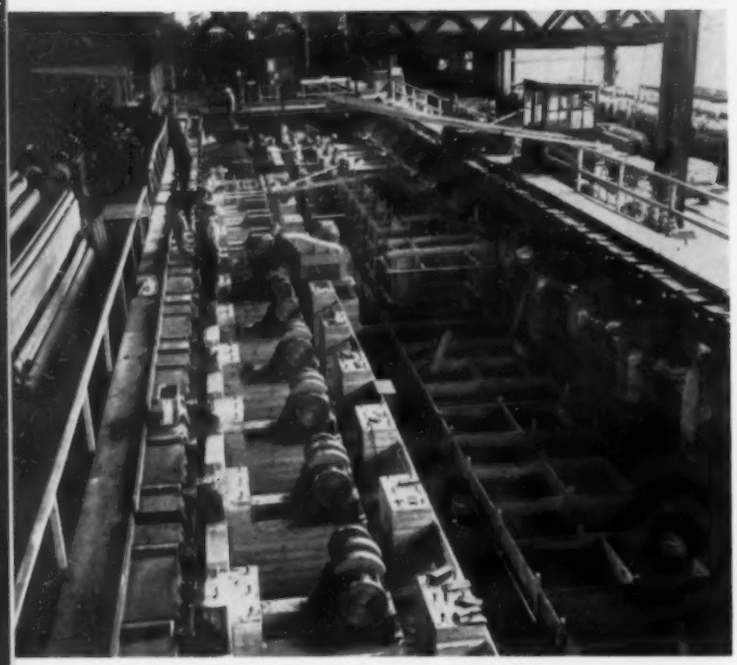


Figure 9 — Various stages of construction can be seen in this view.

Starting in the lower right corner and proceeding counter-clockwise around the excavation are seen the base forms, pier forms, pier forms with anchor bolt templates, crank bases, and drive unit in place. The beginning of the assembly of the crank mechanism is shown at the lower center. The mechanical installation work was done by the same force which manufactured and preassembled this unit.

Figure 10 depicts the final stages of installation with the fitting of the grates. During this phase of the operation, all electrical circuits were checked and the mechanical connections were inspected to insure proper fit and alinement. This final inspection was made by the electricians and machinists who maintain this unit.

Figure 10 — Fitting of the grates is now taking place.

Figure 11 — First order is shown going over new cooling bed.

Figure 11 shows the completed project with the first order crossing the bed. As indicated above, this unit was engineered, manufactured, and installed by plant personnel. The fabrication of the mechanical parts took a full year to complete, whereas the 18-in. mill was down only three weeks for the removal of the old cooling bed, the construction of the new concrete piers, and the installation of the new bed.

As a matter of interest, because of the scope of this project and the limited manpower available at the time, outside contractors were originally contacted to construct certain portion of the installation. However, it was determined that the cost savings resulting from installation by the plant maintenance department more than justified channeling the full maintenance force into this one project.

Figure 12 illustrates another project which was constructed in the same manner as the 18-in. mill cooling bed. The bar transfer beds, shown on either side of the 12-in. mill, were fabricated in the shops, preassembled and operated prior to final placement, and installed during a mill shutdown period.

These two beds were designed to transfer the bars from one stand to another and to return the bars to the mill. The controls for the transfer mechanism are operated by foot buttons, and can be regulated to locate the bars for entrance into any one of the succeeding stands.

This mechanical equipment made it possible to eliminate the previous hand method of working the mill, to increase mill production, and to enlarge mill product range.

A final example emphasizes the necessity of planning and cooperation in order to complete a project without interference with the continuous operation of the producing units. Figure 13 shows the installation of a high voltage distribution and main feeder breaker panel. When the picture was taken, the project had not been completed, as can be seen by the presence of a portion

Figure 12 — Shop personnel were used to manufacture bar transfer beds.

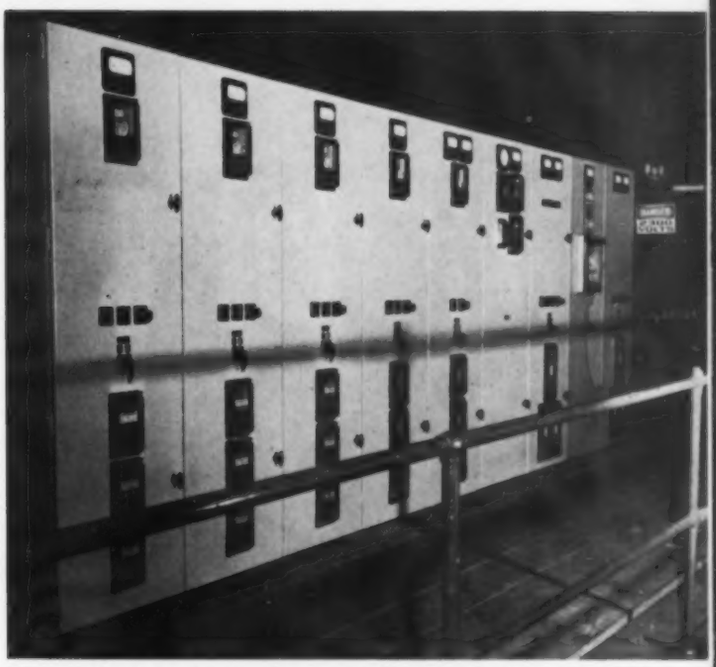


Figure 13 — New high voltage distribution and main feeder breaker panel was installed in such a way, over 16 week-ends, to eliminate delay time.

of the old switchboard at the extreme right. At this point and throughout the job, the producing units were kept operating on part of the old switchgear and that part of the new gear which had been installed. All troughing, buss bar, and cabinet supports were prefabricated. By installing all new feeders prior to the removal of the old gear, it was possible to proceed step by step, during scheduled mill shutdown periods, for sixteen consecutive weekends, to the final completion of the installation.

In conclusion an integrated maintenance and development program will improve present operations and promote the growth of the small tonnage steel plant. Adequate time, careful planning, and diligent cooperation will accomplish this goal in the most economical manner.

WAY DEVELOPED TO RECOVER ZINC FROM GALVANIZER'S WASTE

▲ CREATION in a Bureau of Mines laboratory of a new process that promises to conserve zinc, a strategic metal, and help overcome occasional zinc shortages was announced recently.

The process salvages galvanizers' sal skimmings which form on the top of dipping tanks and which are skimmed off and often wasted. By using an electrolytic method, Bureau researchers produced 99.99 per cent pure metallic zinc from the skimmings and succeeded in recovering more than 90 per cent of the contained zinc, according to a Bureau technical report.

Unlike the other zinc-bearing wastes of the galvanizing industry, largest single consumer of slab zinc, sal skimmings do not respond to smelting and distillation. Heretofore the 25,000 tons or more of skimmings produced annualy have been used as a source of such compounds as zinc chloride, and their price has remained low even during zinc shortages.

The Bureau-originated technique, described in detail in the report, written by P. M. Sullivan, chemical engineer, involves leaching the skimmings with spent electrolyte and hydrochloric acid, then placing the resulting solution in an amalgam cell where virtually all the contained zinc is recovered electrolytically.

The report cites the following advantages that should make commercial use of the process attractive.

"(1) Extremely high purity zinc is produced in a one-step operation from a relatively impure electrolyte; (2) no complicated electrolyte purification steps are required; (3) chlorine, a valuable byproduct, also is produced; and (4) current efficiency is very high."

A copy of R. I. 5205, "Electrolytic Recovery of Zinc from Galvanizers' Sal Skimmings," by P. M. Sullivan, can be obtained from the Bureau of Mines, Publications Distribution Section, 4800 Forbes Street, Pittsburgh 13, Pa. It should be identified by number and title.

Four Open Hearth Furnaces designed by Rust for Lone Star Steel Company's modern steel mill at Lone Star, Texas

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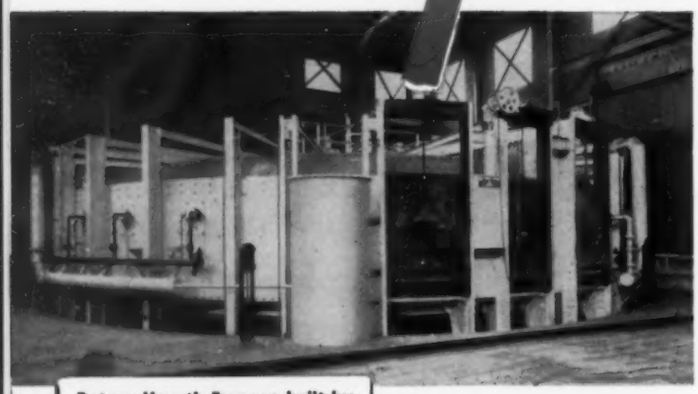

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ORE UNLOADING FACILITIES AT SOUTH CHICAGO

By W. B. McLEAN
Structural Engineer
Engineering Works Division
Dravo Corp.
Pittsburgh, Pa.

▲ INSTALLATION of seven new ore unloaders at United States Steel Corp.'s South Works, Chicago, has modernized and speeded up the removal of ore from lake boats at this facility. Three unloaders are on one runway at the plant's south dock and the other four on a second runway at the north dock about a mile away.

These replace 11 units which had been in service for many years. The three new machines at the south dock can unload 10,000 to 16,000-ton ore boats at average turnaround rates of 7 to 8½ hr. This is an improvement over the capacity of the seven machines which had been on the dock. The plant receives and unloads approximately 5,000,000 tons of ore and 800,000 tons of limestone annually.

Among the advantages of the new unloaders are maneuverability, increased bucket speed, quick changeover to clean-up buckets, and compact length to permit working close together.

The unloaders were designed and fabricated by American Bridge Division of U. S. Steel Corp. and Dravo Corp., Pittsburgh, furnished the mechanical equipment.

The unloaders on the two docks are generally similar. They are of open steel framework construction. The ones on the south dock consist of a 165-ft trolley runway supported by a 70-ft high tower 31½ ft long and 35 ft wide. They travel along the dock on two single rail tracks spaced on 31½ ft centers. The inner, or land side, rail is 16 ft above the dock floor on which the outer, or "water," rail is located, and is carried on top of a concrete wall which forms one side of a 37-ft wide ore trough from which ore is moved by bridges to the main ore storage yard. The unloader runway is cantilevered out over the trough and passes under the arms of the ore bridges.

One feature of tower design allows the unloaders to work close together on the dock. Legs of the tower are tapered in toward the bottom to keep the trucks from extending beyond the base of the tower. Overall width at the base is 46 ft. The eight-wheel, 20-ft long trucks are kept within this width by supporting the tower on centers 26 ft apart. Additional stability to compensate for the relatively close spacing of the wheels is provided by heavy construction, which also makes the structure rugged and durable.

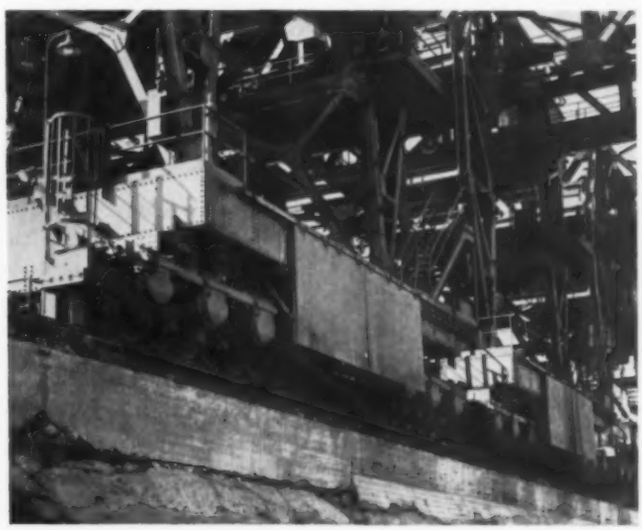
Ore or limestone can be removed from the hold of a vessel and dumped into the ore trough at the rate of 1060 tons per hr by each unloader under "free digging" conditions. The main buckets, of 150 cu ft capacity, are of the four-line rope-reeved type. Trays are reversible and adjustable for wear.

The clean-up buckets have two important features: they can open to a length of approximately 20 ft, yet have a closed length of about 6½ ft. This short length in closed position makes it possible to lower the bucket through narrow hatch openings. Under the deck, the jaws are opened to a maximum spread of 20 ft which, in combination with the 10½ ft jaw width, provides an overall clean-up area of 210 sq ft.

The trolley runway projects 55 ft

Figure 1 — Three ore unloaders that work side by side on the south dock at U. S. Steel's South Works in Chicago are among seven new machines that have been installed to modernize and speed up removal of ore from lake boats.

Figure 2 — Inner rail for unloaders on the south dock is mounted on a concrete wall that forms part of an ore trough. Each unloader travels on four 20-ft long, eight wheel trucks, one at each corner.



out over the ore trough, extends through the upper portion of the tower, and 78½ ft out over the water side. A 67-ft hinged apron section forms part of the runway on the water side. The apron is supported by a mast extending 30 ft above the top of the tower. A set of linked eyebars runs between the top of the mast and the outer end of the apron, with a set of lifting falls provided to raise the apron nearly vertically to clear ships' rigging. In the raised position it is latched.

Apron hoist unit and electrical equipment for controlling tower travel motors are in a house on top of the tower. The trolley carries its own operating equipment and controls in a house beneath one end of the main trolley frame. The operator's cab, insulated and heated, is suspended on the trolley below this house and provides maximum visibility during handling operations. The trolley control enclosure is divided into three sections. Resistors are in the two outside sections, which are provided with vents and louvres for ventilation and cooling. This design also keeps the control panels clean and lessens maintenance requirements.

A 10-ton repair trolley is carried by a transverse beam that extends across one end of the apron hoist house and cantilevers through a pair of swinging doors out beyond the side of the tower. The repair trolley also services the main trolley through a trap door in the floor of the apron hoist house.

The trolley frame is a rigid structural steel weldment, approximately 34 ft long and 10 ft wide. Substantial weight savings were achieved by using high-strength tri-ten steel for the 30-in. main side beams, and corrosion-resistant cor-ten steel for the floor plates which are reduced to ¼-in. thickness. A transverse box section near each end of the frame increases its torsional stiffness.

Four 30-in, diam trolley wheels are made of rim-toughened wrought steel with tapered tread and single flange. They are mounted on two forged steel axles, 26½ ft center-to-center and run on 105-lb per yard rails, spaced 11 ft-3 in. center to center. The axles are driven independently by 125-hp electric motors through a single gear reduction with double helical gears. Axles turn on anti-friction bearings, the housings of which are spring-mounted on the trolley frame.

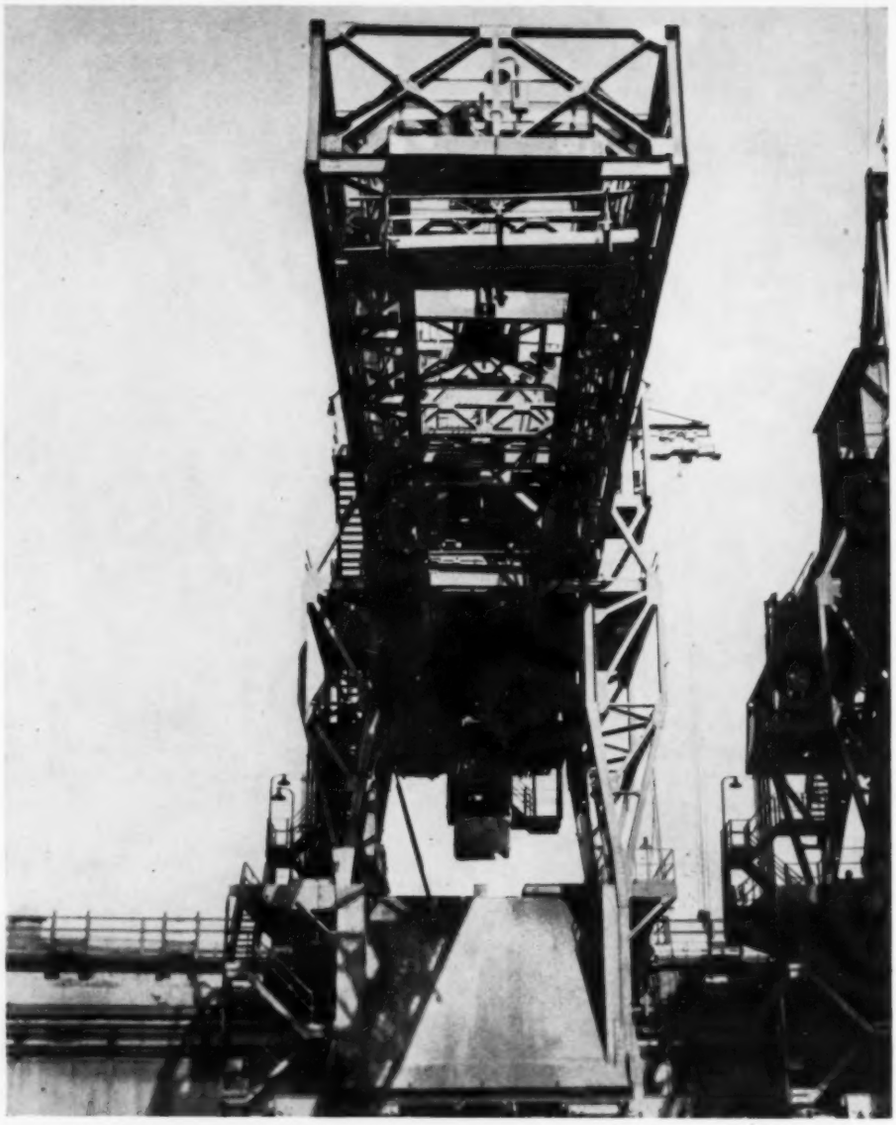


Figure 3 — A sloping shield plate between the bucket platform and the tower legs helps speed unloading operation. The operator can begin inboard trolley travel motion soon after start of the bucket lift with no obstructions to impede the operations.

All trolley bearings except motor bearings are lubricated by a centralized lubrication system. Brakes are electrically operated. Safety lugs at each corner of the trolley frame guard against the possibility of a fall if an axle should fail. Screw jacks built in these lugs also serve to lift the trolley for wheel maintenance.

The bucket hoist, centered in the frame, consists of a holding drum and a closing drum. Transverse drum shafts are supported on self-alining anti-friction bearings assembled in cartridges. Each drum is driven independently through a double-gear reduction by 250-hp electric motors, each equipped with a magnetic brake. Drum gears are bolted to their respective drums and operate in oil-tight cases. The drum pinion and gears are of the spur type, and the motor gears and pinions are double helical. The drums carry a single layer of 1⅛ in. wire rope.

Quick bucket changeover, another feature of the new unloader, is achieved by means of the storage platform 27 ft above dock level and under the tower runway. Two bucket buggies, moved by an electric winch on a transverse track, greatly reduce the time of changing buckets.

Structural parts of the unloader were built to the American Railway Engineering Association Specifications for Steel Railway Bridges. Trolley rails are set vertically (i.e., not canted) and are cushioned by continuous $1\frac{1}{32}$-in. thick fabreeka pads. The supporting stringers are rolled

(*Please turn to page 202*)

Stearns circular lifting magnet carrying a 4,000-lb tank track.

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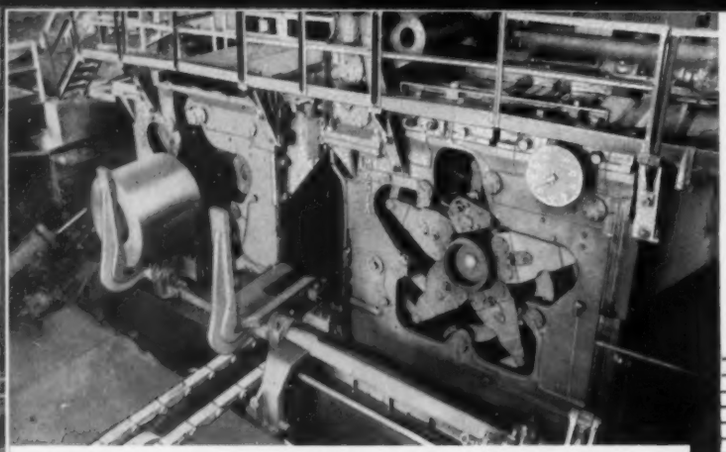
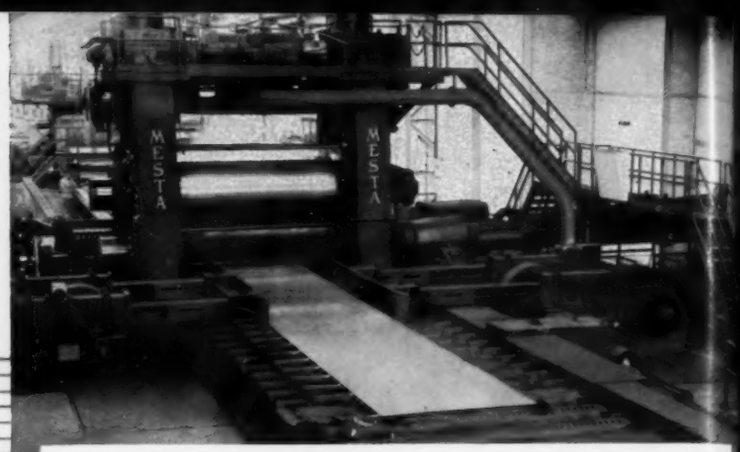


DOWN COILERS WITH ROTATING AND EXPANDING MANDRELS
ON A MESTA 60" HOT STRIP MILL



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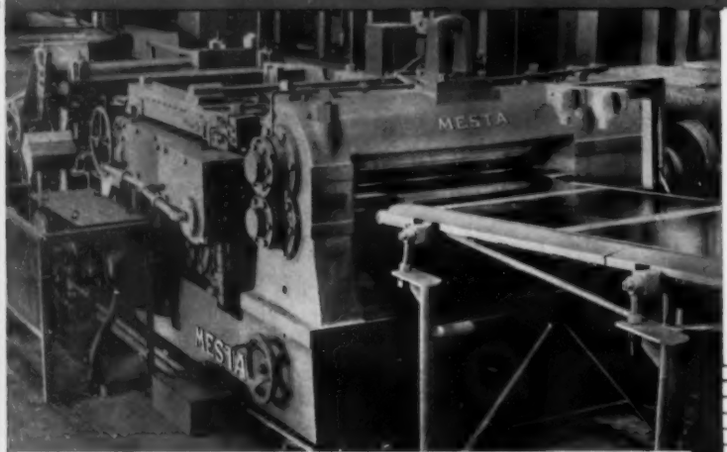

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AT 1,200 FT. PER MINUTE ON AN ELECTROLYTIC TINNING LINE

MESTA 46" TWO-HIGH REVERSING SLABBING-BLOOMING MILL
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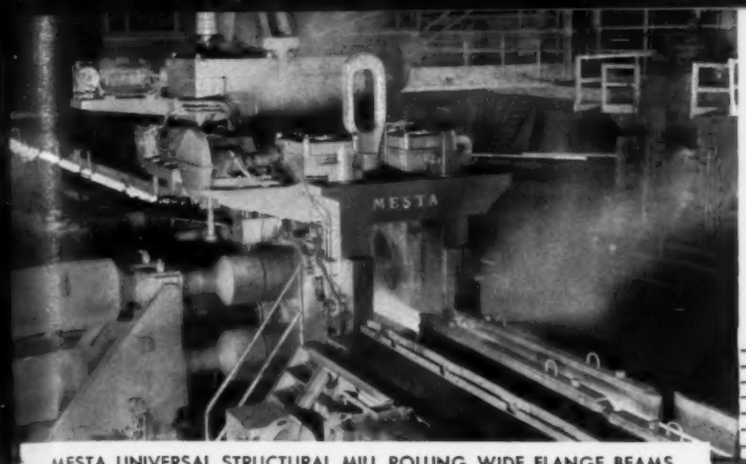
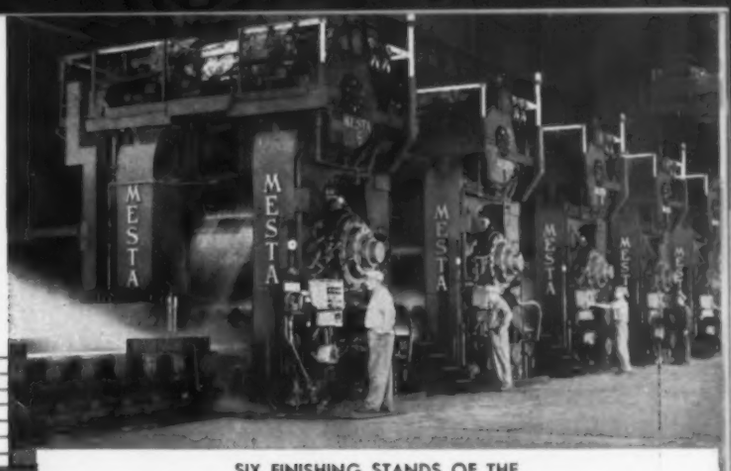
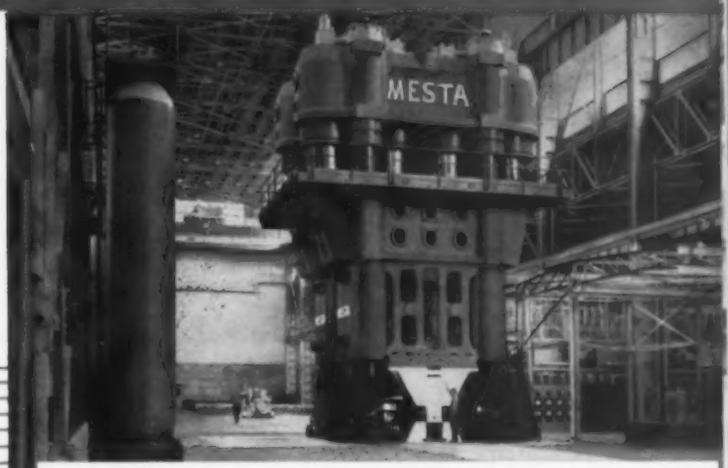


MESTA UNIVERSAL STRUCTURAL MILL ROLLING WIDE FLANGE BEAMS ON THE 44" UNIVERSAL STAND AND 34" EDGING STAND



SIX FINISHING STANDS OF THE MESTA 60" FOUR-HIGH HOT STRIP MILL

MESTA 60" SHEET SHEARING LINES WITH TRIMMERS AND COMBINATION ROTARY FLYING SHEARS AND LEVELLERS



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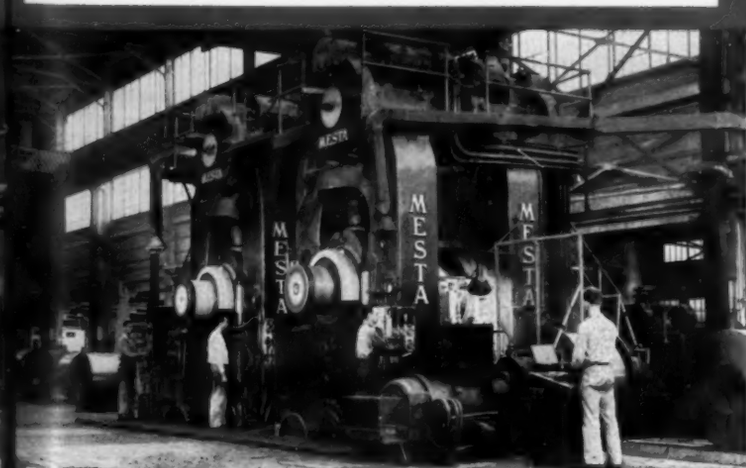
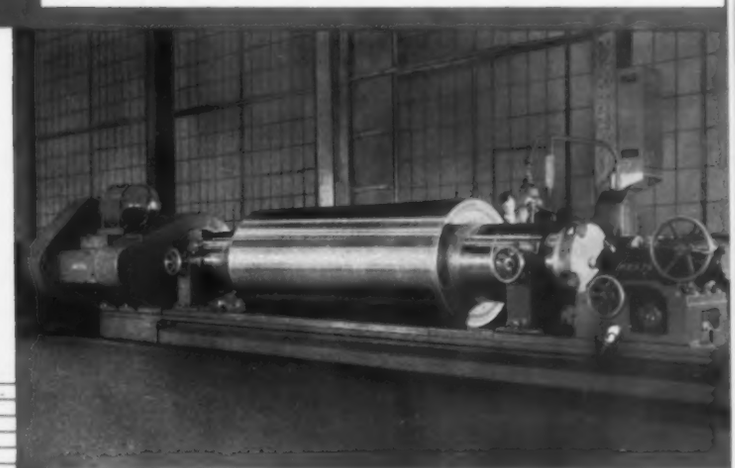


MESTA 42" FOUR-HIGH TWIN-STAND SKIN PASS MILL



MESTA HEAVY-DUTY TRAVELING WHEEL TYPE ROLL GRINDER FINISHING A 59" X 154" MESTA BACKING-UP ROLL

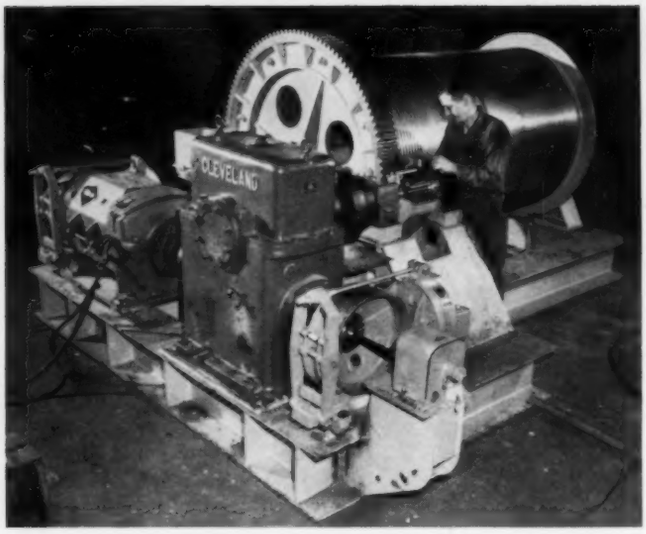


Figure 4 (left) — Shop assembly view of the unloader trolley presents a detailed insight into its design. Some 34 ft long and 10 ft wide, the trolley is a rigid weldment with four 30-in. diam wheels, one near each corner. Bucket hoist unit, with holding drum and closing drum, is centered in the frame. When fully assembled, the trolley supports the operator's cab and equipment house. Figure 5 (right) — Apron hoist unit consists of a single welded steel drum driven by an electric motor flexibly-coupled to a worm gear reducer. This reducer, in turn, is connected to an intermediate shaft carrying the drum pinion. The drum holds all of the ⅞-in. diam wire rope in a single layer.

(*Continued from page 198*)

beams, supported at about 11-ft spacings by cross frames at the truss panel points.

Warren-type trusses for the runway vary from 10 ft to 13 ft-6 in. in depth and are spaced 21 ft center-to-center transversely to provide rigidity and to control deflection under load. They are of double web construction, the chords being generally two angles welded together to form an inverted channel, with a reinforcing tee in the bosom where necessary. Web members are rolled beams. Trusses are braced in the plane of the top chords. The apron, similarly constructed, is hinged at the inner end of the top chord.

The apron is lifted by two equalized sets of falls having seven parts of ⅞-in. wire rope each. One lead line from each set is attached to the welded steel drum of the apron hoist. The drum is driven by an electric motor flexibly coupled to a worm gear reducer which, in turn, is connected to an intermediate shaft carrying the drum pinion. This meshes with a spur gear bolted to the drum and operating in an oil-tight case. Bearings for intermediate and drum shafts are bronze. The drum carries all of the rope in a single layer.

The apron is latched in raised position by a structural member pivoted at the top of the tower mast. At its outboard end the member is hook-shaped to engage a pin in the apron structure. After engaging this pin, the hook is dogged to prevent the apron from being unlatched accidentally. A limit switch in the control circuit closes the apron hoist power circuit when the latch dog is lifted. A second limit switch serves as a final emergency stop if the apron is pulled in too close to the tower.

To lower the apron, the latch dog is raised by a hand-operated winch which automatically trips the limit switch. After the apron has been pulled in sufficiently to disengage the apron pin, the same winch raises the hook point so that the apron can clear it.

Dravo hydraulic buffers at ends of the runway are capable of absorbing the energy of the loaded trolley at full speed. The buffer on the land end is a 6-ft stroke, pull-type with latch return. This consists of two cylinders connected by tension rods to a cross beam resting on the rails and supported on the walkway just outside of the runway stringers. An automatic latch provides for resetting the cross beam when the trolley backs away from the bumper. It also disengages the trolley at the proper point.

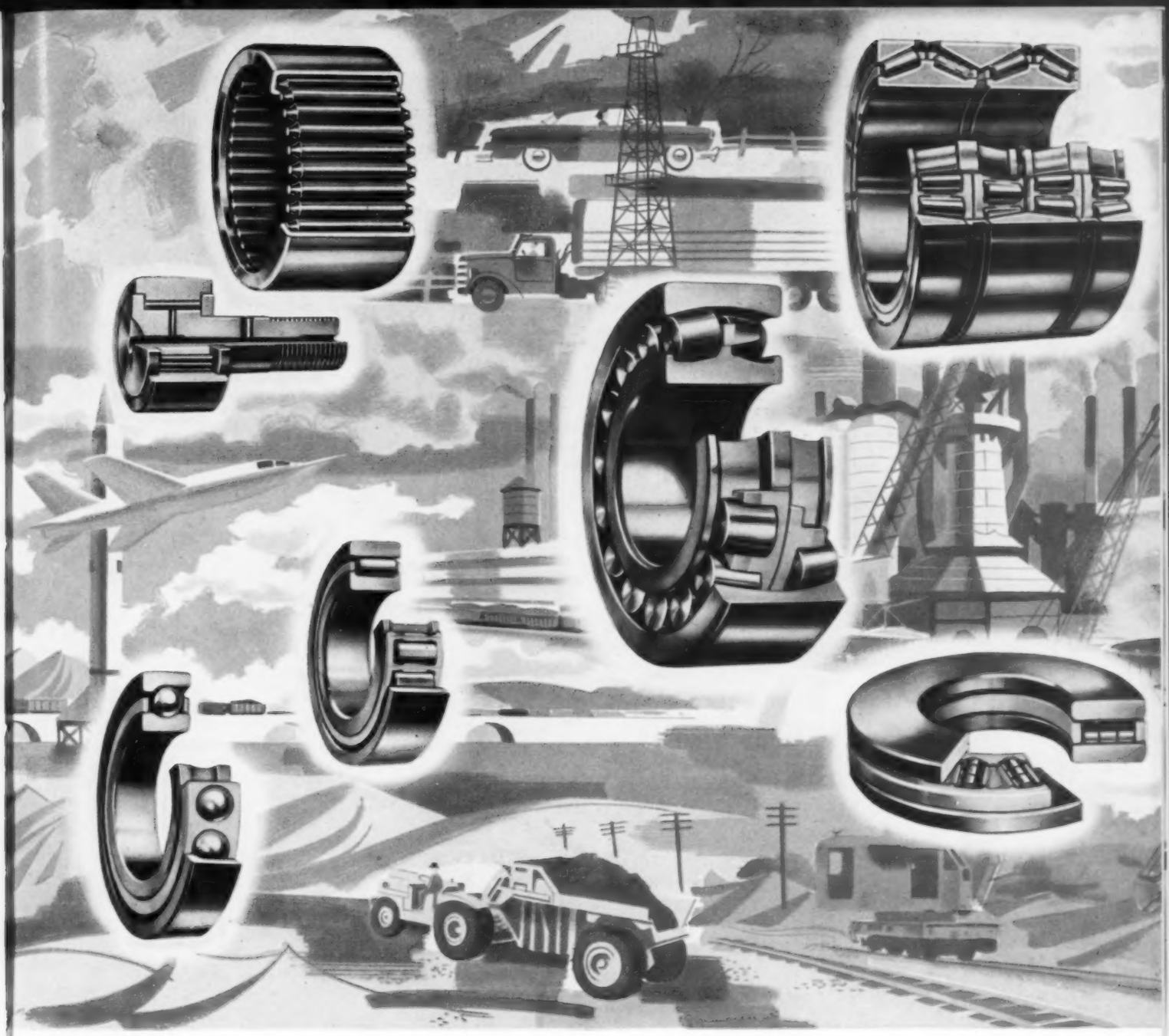
Buffers with 2-ft stroke are mounted at the water end of the runway. The buffers have pistons operating in perforated cylinders. Perforations are spaced to maintain braking force practically constant throughout the stroke. Fluid escapes through a decreasing number of openings as the speed of the piston is reduced. A characteristic of these hydraulic buffers is that the piston will travel the same distance in the housing when struck by a free-running trolley regardless of its speed. During tests of the first unloader completed, the trolley was allowed to run into the buffers at full speed, with representatives of both U. S. Steel and Dravo on board.

When the apron is raised, the trolley is protected from overshooting the water end of the runway by a simple mechanical barricade which drops into place automatically as the apron is raised.

The tower is a riveted structure built mainly of 12-in. beams. At the runway level the entire area, except the runway, is plated over to form a repair and service platform.

Installation of a sloping steel shield plate, extending downward from the bucket platform between the tower legs on the water side, helps speed unloading operations by permitting a sweep type cycle. This plate is 22 ft wide and has about a 60 degree slope. The area under the tower is protected from ore that may spill from the bucket. Thus, the operator can begin his inboard trolley travel motion very soon after he starts the bucket lift.

A structural stability problem, posed by the narrow width of the tower runway, was overcome by design techniques. High stability of the tower, with the trolley far out on the



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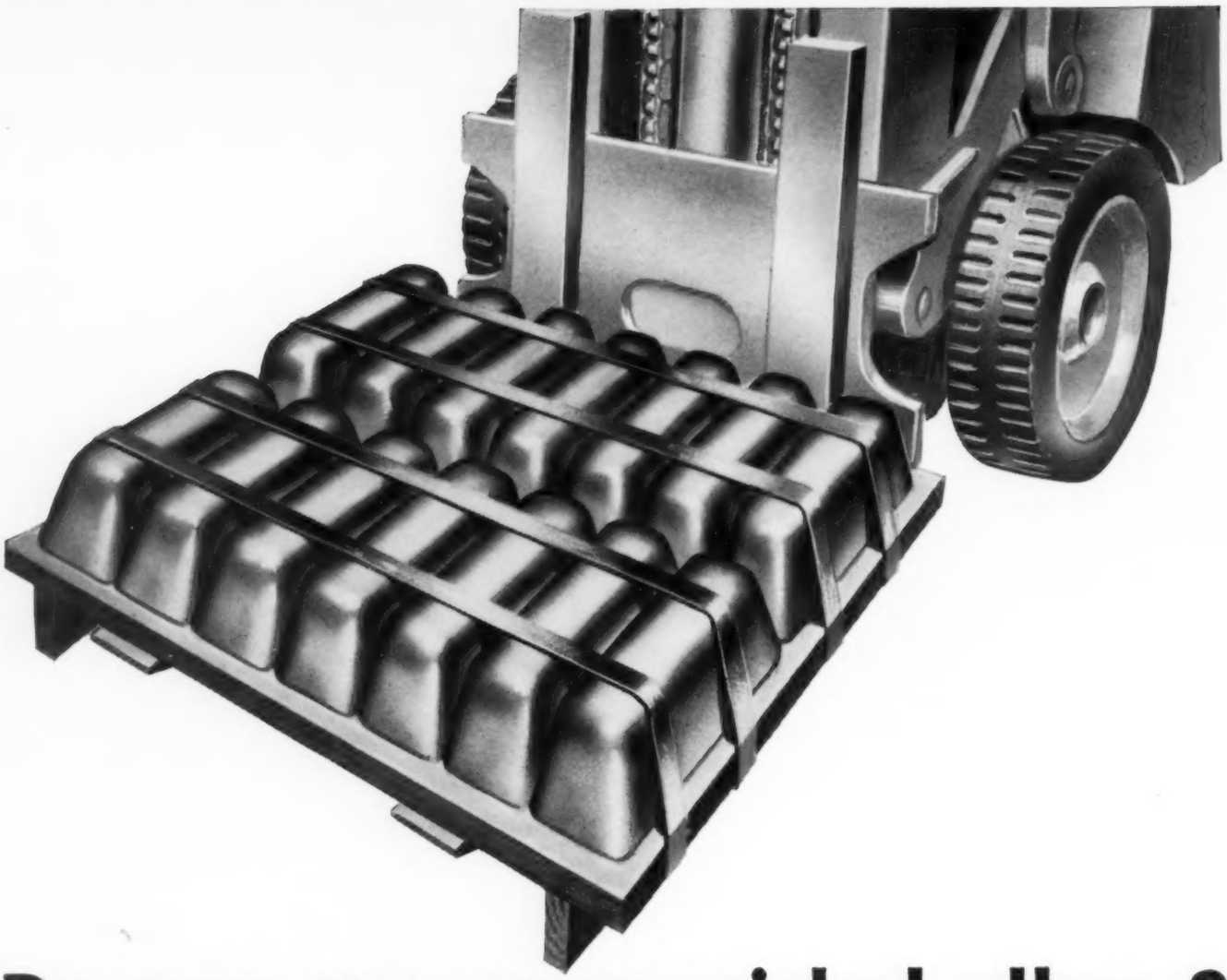

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apron, is assured by a "counterweight box" which forms the rear end of the bucket platform. The box is filled with 250 tons of composite concrete weighing 250 lb per cu ft. This design allows for the worst trolley position with an impact equal to 10 per cent of the loaded trolley plus a wind of 30 lb per sq ft. Further safety is achieved by heavy brackets from the bottom of the bucket platform which project under a continuous inverted shelf angle that is fastened to the steel rail beam on the inner dock wall. They prevent uplift of the rear legs of the structure.

Trucks at each corner of the tower structure are independent assemblies, consisting of eight fully equalized 27-in. diameter wheels driven by a single motor. The motor for each truck assembly is flexibly coupled to a worm reducer driving a longitudinal shaft which transmits force through four truck worms. Intermediate drive shafts from the truck worms have spur pinions which mesh with gears on the wheels. Truck worms are mounted in anti-friction bearings in an oil-tight case on the intermediate shaft.

Main truck equalizers and all sub-equalizers are of heavy welded construction and are pin-connected one to the other. These are nested to reduce the height. The intermediate shaft for each pair of wheels is mounted in a cast steel quill which serves as the equalizing pin at those points and also carries the worm set housing.

Special jacking beams can be bolted to the main equalizer so the structure can be jacked to replace truck elements. Four beams permit jacking one side of one unloader at a time.

All parts of the unloader requiring service and maintenance are safely accessible by stairs, walks, and platforms. The top of the apron mast is reached by a ladder from the apron hoist house floor. Stair treads and walks are of open steel grating.

The unloaders operate on 230-volt, d-c current. Motors for all main drives are 600 series mill type. Bucket hoist controls and apron hoist control are full magnetic, reversing dynamic lowering. Trolley travel and tower travel controls are both duplex full magnetic, reversing-plugging.

Limit switches are provided to:

1. Slow down and stop the trolley as it nears the end of the runway.
2. Prevent collision of adjacent towers.
3. Control torque to tower drive motors depending on location of trolley.
4. Slow down and stop the apron at upper and lower limit of its travel.
5. Prevent hoisting of the apron when the latch is engaged.

A Burton anemometer on the mast shuts down the tower travel if the wind exceeds 30 miles per hr.

The four unloaders for the north dock at the plant are virtually the same as the first three. The north dock is similar to the south dock in construction and arrangement except that the rails are 38 ft center-to-center, as compared with 31 ft 6 in. on the south dock. There are also minor differences in elevations of rails, making a slight difference in height of the towers.

WASHINGTON STEEL STARTS NEW 52-IN. SENDZIMIR MILL

▲ A MAJOR step in the expansion program of Washington Steel Corp., Washington, Pa., was completed with the recent start-up of a 52-in. Sendzimir reversing cold strip mill. This will more than double the capacity of this producer of cold rolled stainless steel sheet and strip, and indicates the progress the company has made since it was incorporated about eleven years ago.

Since the company produces no steel, hot rolled stainless steel coils are purchased from outside companies. The Washington plant includes facilities for pickling, annealing, cold reduction, grinding, polishing and slitting or shearing, as required. Various types of chromium and chromium-nickel stainless steels (430, 302, 202, 304, etc.) are processed into cold rolled sheet or strip in several different finishes (No. 2, 3, 4, and 7). The product is marketed under the trade name MicroRold stainless steel.

The new mill is capable of rolling up to 3500 tons per month of coils of 48-in. maximum width. It is a typical Sendzimir design, using two work rolls 1.96 in. to 2.35 in. in diameter and 52 in. long, backed up by four intermediate rolls of 4-in. nominal diameter, 54 in. long. These first intermediates are in turn backed up by six second intermediate rolls of 6.812-in. nominal diameter and $56\frac{3}{16}$ in length, which are in turn supported by eight rows of backing bearings 11.811 in. in diameter. Each row of bearings consists of six bearings on a dead shaft. It is these bearings which carry the mill pressures, while the intermediate rolls serve only to transmit the pressures from work rolls to the bearings.

Work rolls may be made of various steels or of sintered carbide. At present, high speed steel rolls are used, with a hardness of 62 to 66 Rockwell C. They may be ground straight or with a slight crown, but must be with-

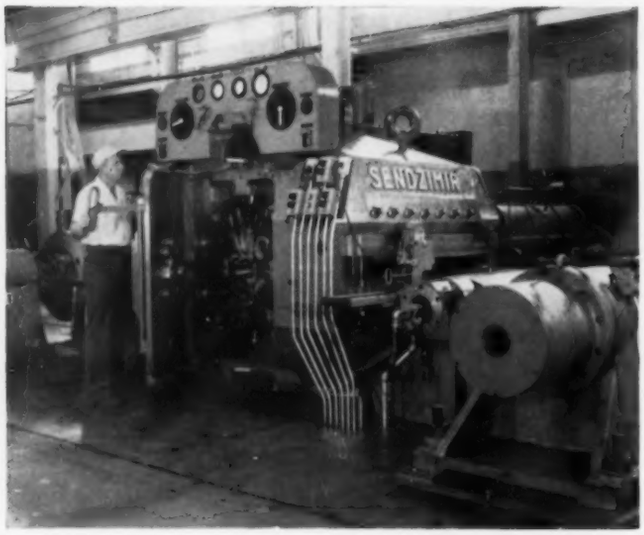

Figure 1 — The new 52-in. mill can roll sheet up to 48 in. wide in coil form. It has a monthly capacity of 3500 tons.

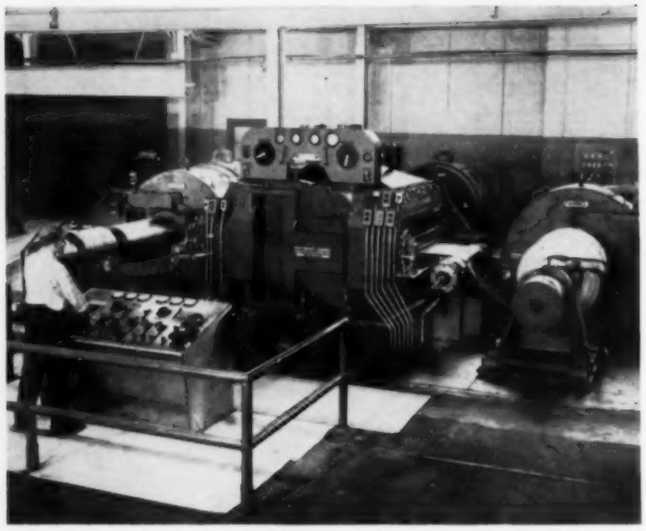

Figure 2 — Work rolls may be changed several times during the rolling of one coil because of the speed with which they may be replaced.

in 0.0002-in. accuracy from end to end. Because of the speed with which the work rolls can be replaced, they may be changed several times during the rolling of one coil.

First intermediate rolls, of 56 to 60 Rockwell C hardness, may be ground straight or crowned, and again, accuracy from end to end is essential. Second intermediate rolls are 60 to 62 Rockwell C and are usually ground straight. The four that are driven must be within 0.0002 in. of each other on body diameter in order to balance the load on the driving pinions.

The rows of bearings are eccentrically adjusted to open or close the mill. This action replaces the screwdown of the conventional mill. The top and bottom rows at each side of the mill are driven by an electric motor, while the four central rows are operated by hydraulic cylinders. A pressure of 500 psi on these cylinders gives a total mill pressure of 1,500,000 lb, or about 30,000 lb per in. of strip width.

Four of the second intermediate rolls are driven through gearing by a 1000-hp, d-c motor. Each winding reel is also driven by a 1000-hp, d-c motor. The mill drive is geared to give a maximum strip speed of 400 fpm at full torque, and 500 fpm at reduced torque.

Reels will take coils of 22-in. internal diameter and 42-in. maximum outside diameter (about 11,500 lb) and can provide a maximum winding tension of 66,000 lb.

Material coming to the mill averages 0.125 in. in thickness, but thicknesses up to 0.150 in. or more can be handled. Reductions range 15 to 20 per cent in area in each pass. A typical schedule is given in Table I.

Four more passes would be used in going down to approximately 0.01 in. thickness. This mill will roll the hot rolled bands down to finish gage without intermediate annealing.

Lubrication of the mill and rolls is provided by a 600-gpm oil system with storage capacities of 3000 gal for clean oil and 9000 gal for dirty oil. The system includes filters for reclamation of the used oil. Mill pinions and reels are served by a 45-gpm, 1200-gal oil system.

Because of the copious amount of oil circulating within the mill, the mill has wipers on both sides which serve to brush foreign particles off the entering strip, dam the oil from flowing back toward the uncoiler, and dry the strip leaving the mill.

In addition to the new mill, the plant includes a 39-in. Sendzimir mill capable of cold reducing about 1500 tons per month of coils up to 36 in. wide.

TABLE I

Pass	Thickness, in.	Reduction, in.	Reduction in area, per cent
0	0.135	.....	.....
1	0.107	0.028	20.7
2	0.088	0.019	17.8
3	0.073	0.015	17.0
4	0.062	0.011	15.1
5	0.050	0.012	19.4
6	0.041	0.009	18.0
7	0.035	0.006	14.6
8	0.028	0.007	20.0

Annealing and pickling facilities consist of three continuous strand lines with a total capacity of 3300 tons per month. Each line contains a gas or oil-fired furnace 40 to 50 ft long, designed for a maximum temperature of 2250 F. Each line contains a hydrofluoric acid bath, and two lines also have additional electrolytic pickling tanks. Two of the lines contain a Wheelabrator blasting unit, and all lines having dryers, shears and recoilers.

Strip speed through the lines is adjustable from 8 to 70 fpm. Two lines handle material up to 39 in. wide, one up to 50 in. wide.

Further processing may be carried out in a two-high temper mill, two slitting machines, two upcut shear lines, two stretcher levelers, grinding machines, resquaring shears, etc., as may be necessary.

Since the plant product is expensive (averaging about $1200 per ton), it is not surprising that extreme care is exercised throughout the processing to insure a prime product. The company has managed to impress this on the entire working force, with the result that almost every man is something of a yield man and an inspector. The success of this plan is indicated by the fact that plant shipments average 92 per cent of the incoming material.

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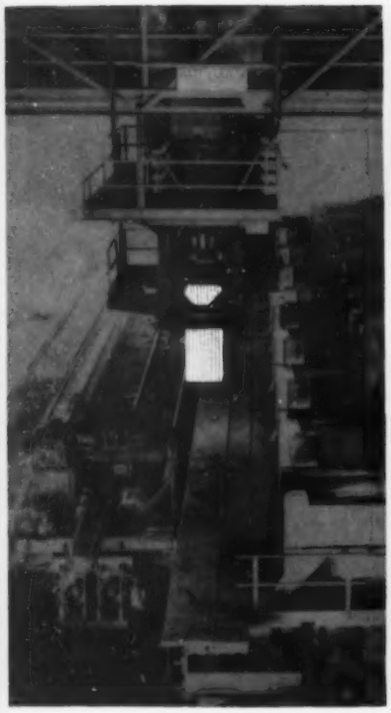

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Surface
STEEL MILL EQUIPMENT

Here's how HOUGHTON

Many things to many men . . . that's the Houghton picture on steel mill applications.

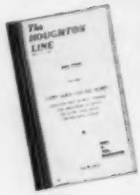
You may know Houghton for its Hydraulic Department, where moulded packings have been made for two generations, and used by practically every steel producer. Current types include leather, synthetic rubber and the new rubber-impregnated leather (VIM 1243) that is taking industry by storm.

Or, you may know Houghton as a specialty lubricant house, fortifying petroleum oils and greases to do vastly improved lubrication jobs . . . open gears, hot spots, lube additives for water systems or for fuel oils . . . scores of items for hundreds of specialized applications.

And it is possible that your knowledge of Houghton has been based largely on its metal-working products: rust preventives, heat treating and quenching oils, cutting oils and bases, pickling inhibitors, hot top insulating materials, hot forging agents.

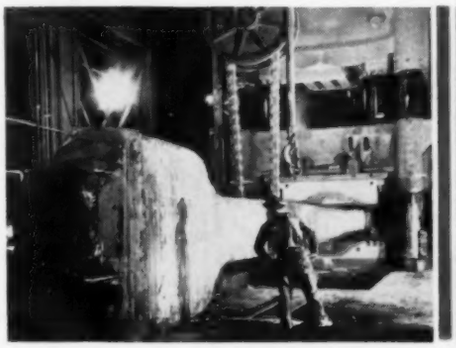
But no matter how you classify this 89-year-young Company, it is certain that Houghton products can be of aid. Behind them is a definite plus value—a field and laboratory service unequalled in our type of industry—also helpful, authoritative publications and manuals highly regarded by metal men.

Get to know Houghton better through the widely known "Houghton Line", published since 1907. If you do not now receive it, write E. F. Houghton & Co., 303 W. Lehigh Avenue, Philadelphia 33, Penna.

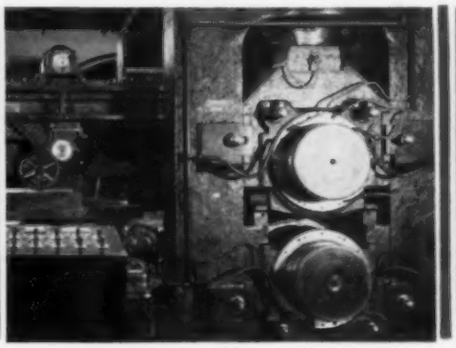


serves the STEEL INDUSTRY

Improve Steel Processing with these Houghton Products

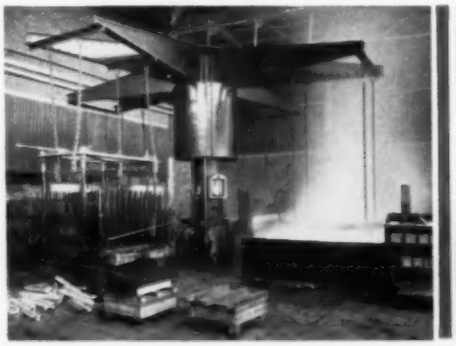


Houghton hydraulic fluids and lubricant additives for water systems, plus Houghton packings, add to useful press life.

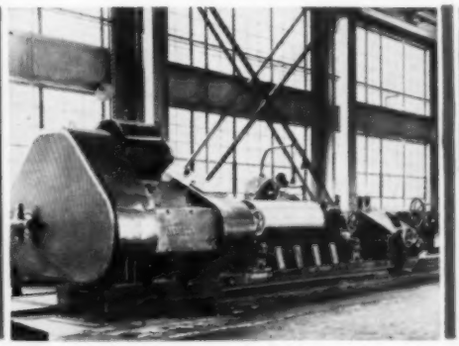


All through the mill Houghton leather and synthetic rubber packings serve long and ably . . . such as on roll jacks, above.

Hydraulic applications, such as dolomite charger above, call for Houghto-Safe nonflammable hydraulic fluid in steel mill hot spots.



Improving Pickling Acitrol pickling inhibitors help conserve both steel and acid. Houghton surface active agents, added to rinse bath, assure quicker, cleaner rinsing.



Precision Roll Grinding Houghto-Grind 50, additive for water used as grinding coolant, assures freedom from early rusting. Rust Veto coatings protect rolls in storage.

Tomorrow's Lubricants, Today Fortified lubricants specifically built for steel mill use will withstand extreme pressures, protect gear sets, function well in pressure systems. Write for special booklet.

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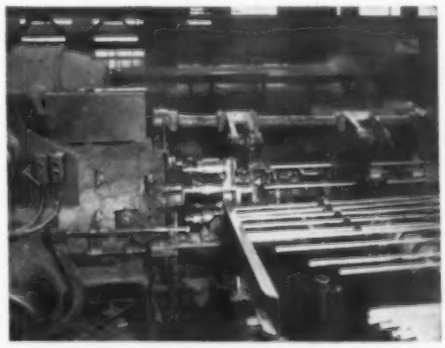

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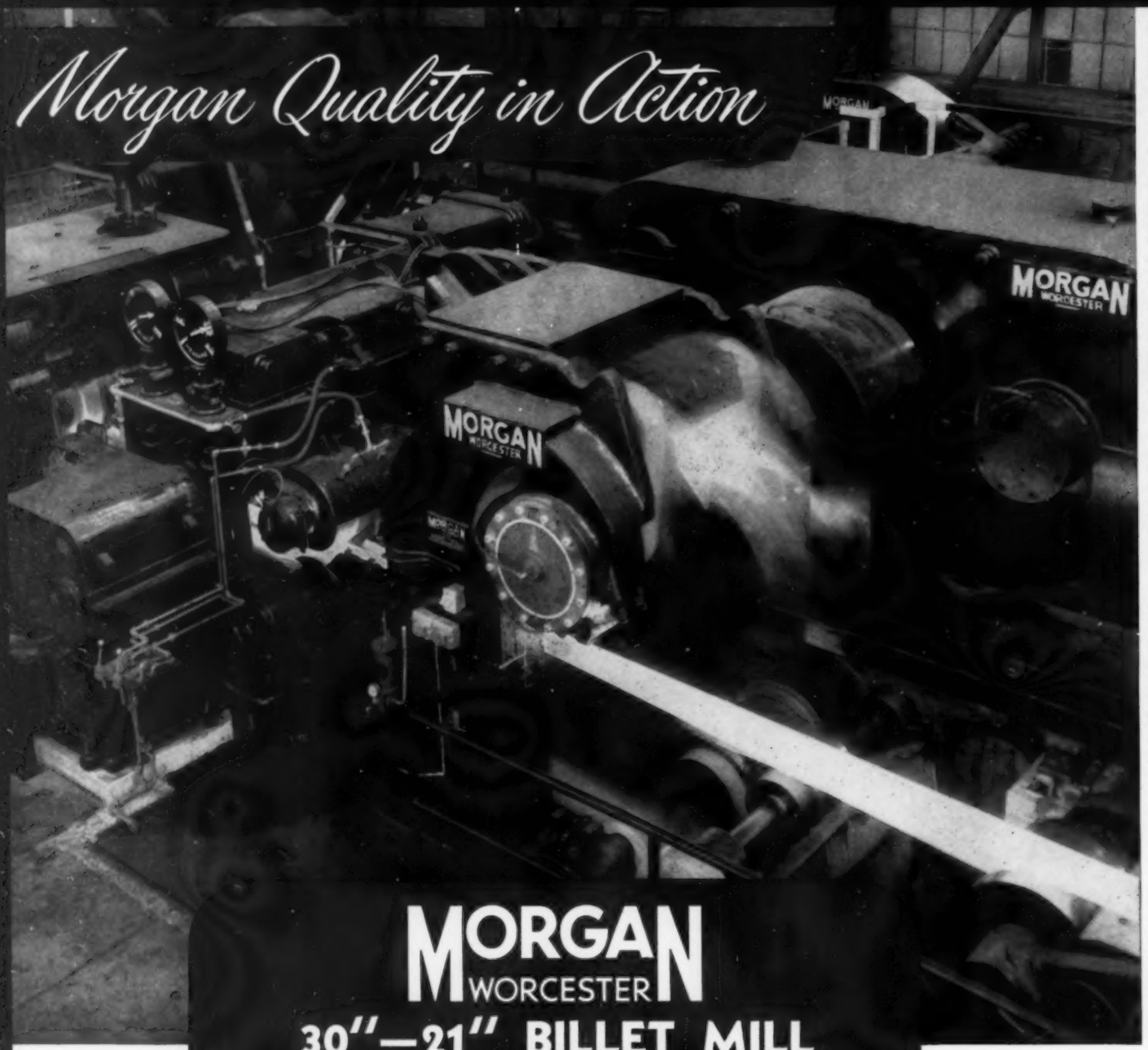

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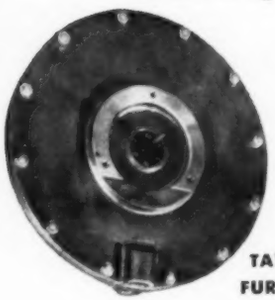
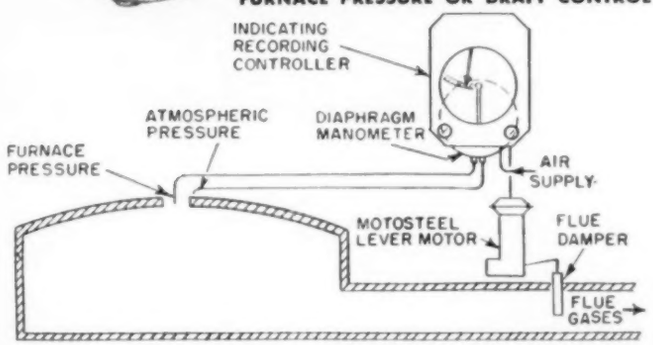


TAYLOR DIAPHRAGM MANOMETER FOR FURNACE PRESSURE OR DRAFT CONTROL



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One of two continuous billet heating furnaces recently installed at Crucible Steel Company, Midland, Pa. for heating carbon and alloy steel billets 4" and 5" square up to 12'-6" long. Four inch square alloy billets are heated from cold to 2350° F. in two hours. These furnaces heat all the steel required by the mill. Completely automatic fuel, pressure, and temperature control are included. —Courtesy of Crucible Steel Company

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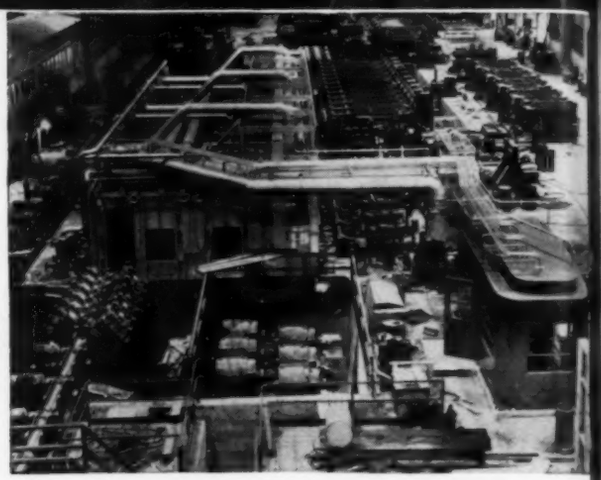
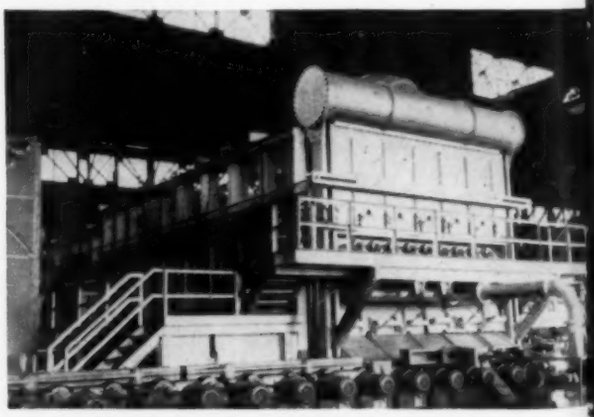


Continuous 75 ton per hour tube reheating furnace installed in one of the largest tube mills in this country. Heats up to 271 pieces per hour of 3½ to 4⅞ inch O. D. pipe up to 65 feet long, to 1850° F. Three zone combustion control heats the tubes uniformly for further processing. Eighteen long flame burners located on each side wall burn coke oven or natural gas.



Continuous 50 metric ton per hour slab heating furnace recently installed in a Japanese steel plant for heating steel slabs 4½" x 24" x 13'-6". *Slabs are heated from cold to 2360° F. in 1½ hours.* Furnace is equipped with two zone, top and bottom oil-fired burners with screening burners on the discharge end. Two built-in tile recuperator cells of 5000 sq. ft. total heating surface, preheat the combustion air to approximately 725° F. This furnace was designed to achieve highest possible heat recovery, due to excessively high fuel cost in Japan.

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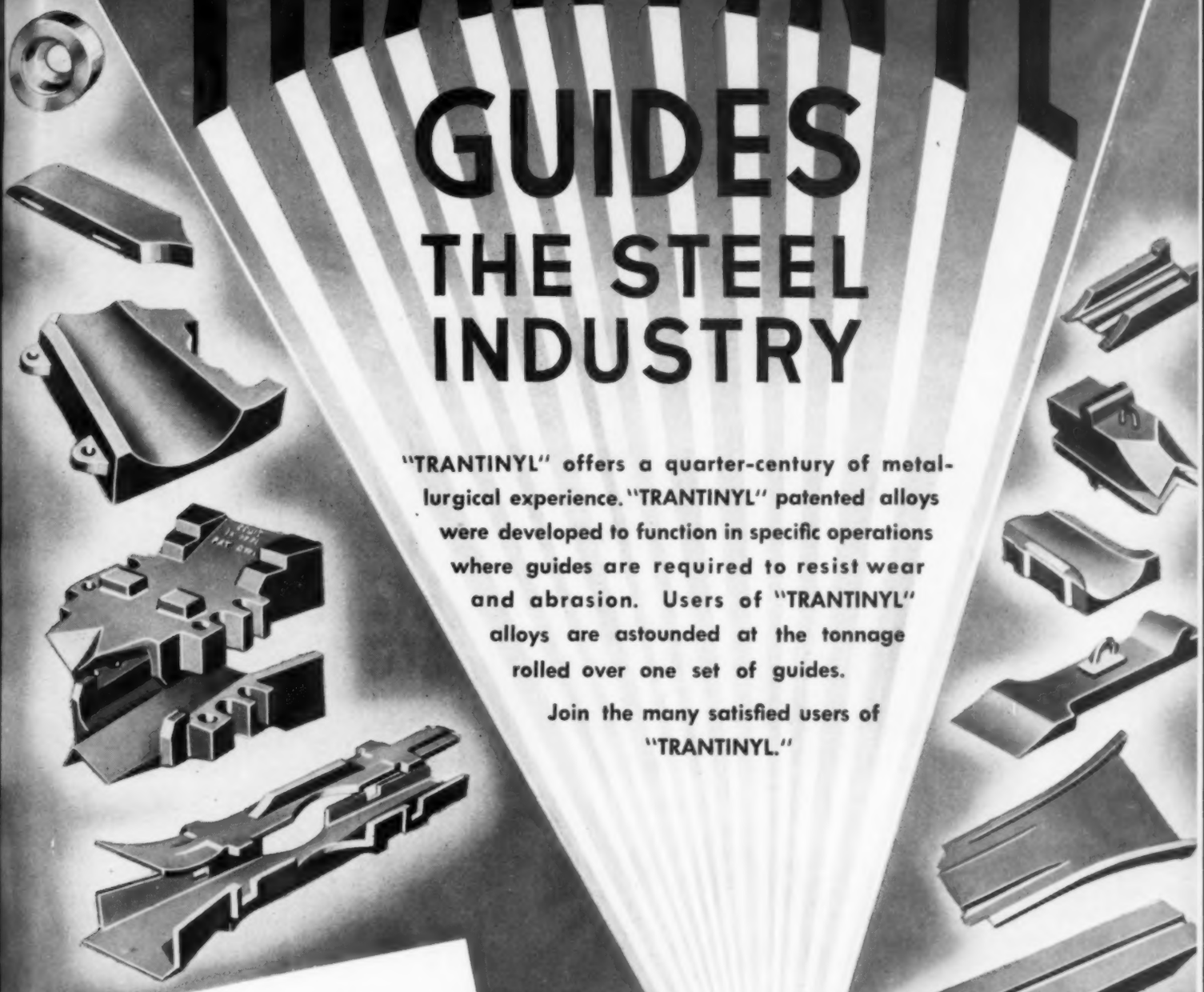

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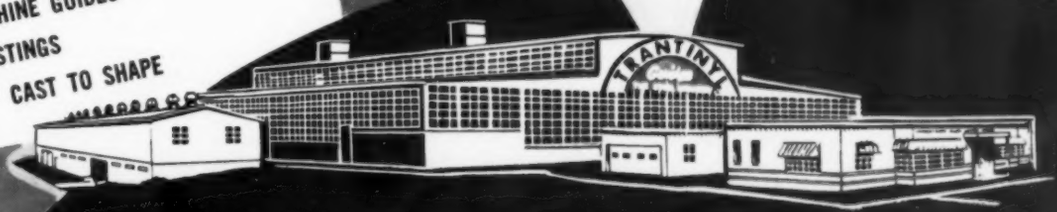

Youngstown Alloy Casting Corporation

Youngstown, Ohio

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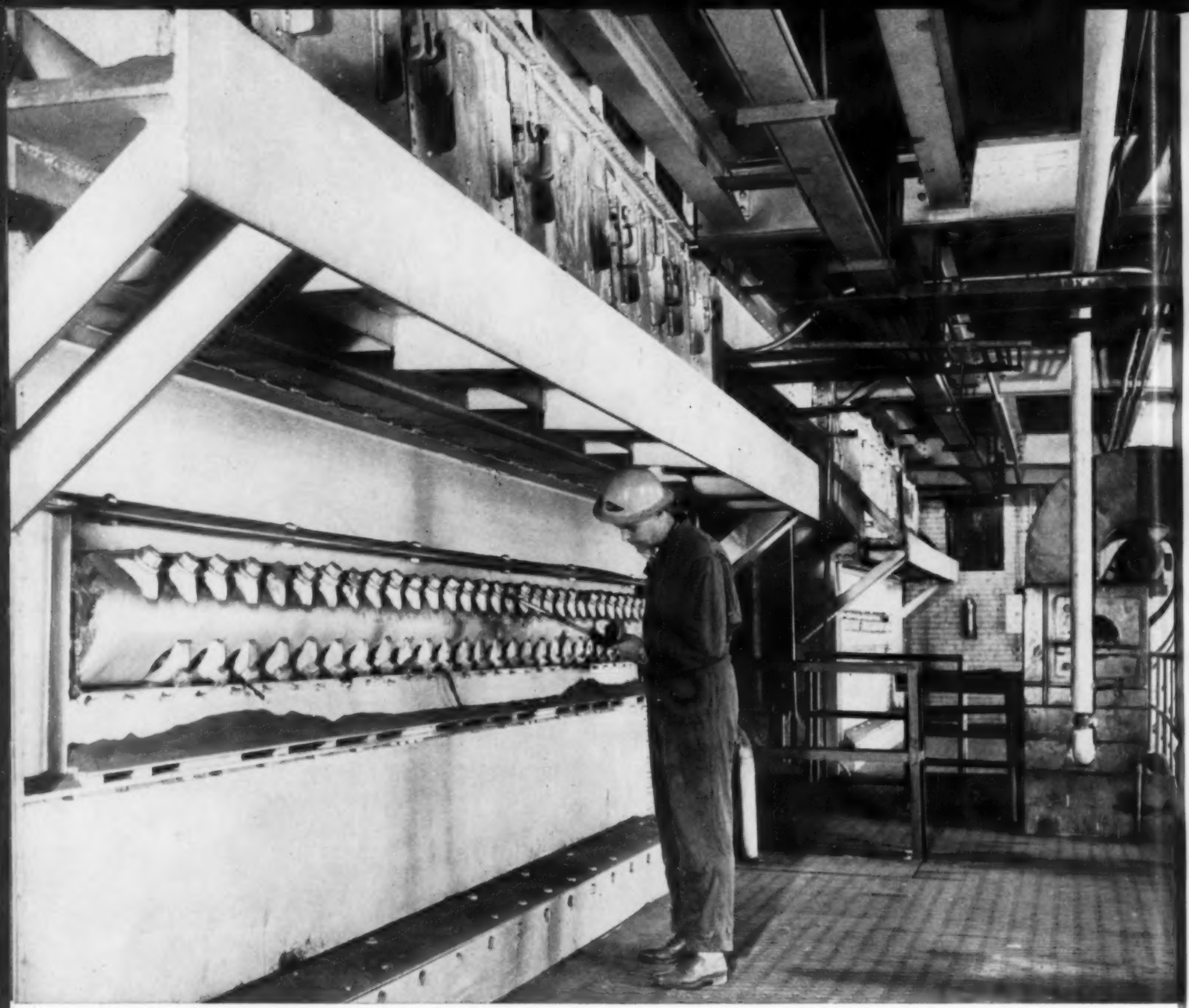

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Date-line Diary...

August 2

▲ Consumer debt in June, 1956 was increased by $299,000,000, and the total instalment debt is now $28,900,000,000, almost $4,000,000,000 above the June, 1955 figure.

August 3

▲ Contracts, embodying in detail the provisions of the 3-year, no strike agreement reached a week ago, between the United States Steel Corp. and the United Steel Workers were signed ending the 34-day shutdown.

▲ The AISC reported bookings for June 1956 of 337,230 tons compared with 358,271 tons in May 1956 and 318,150 tons in June, 1955. Shipments in June, 1956 totaled 284,719 tons, compared with 306,223 tons in May, 1956 and 282,325 tons in June, 1955. Backlog at the end of June totaled 2,858,981 tons.

August 6

▲ The AISI reports that the operating rate of the steel industry for the week of August 6 is scheduled at 52.4 per cent of capacity. This is equivalent to 1,290,000 tons compared with 415,000 tons one week ago and 2,157,000 tons one year ago. Index of production for the week is 80.3.

August 7

▲ The United States Steel Corp. and its general operating divisions, The American Steel and Wire, National Tube, and Tennessee Coal and Iron Divisions, announced an increase averaging $8.50 a ton in its carbon and alloy steel prices. The increase which amounts to approximately 6.25 per cent is to provide for rising costs and includes the 7.6 per cent approximate increase in labor costs which the new labor agreement entails.

▲ Kaiser Steel Corp. placed $100,000,000 of securities consisting of $70,000,000 of 4¾ per cent first mortgage bonds, due 1976, and $30,000,000 of 5 per cent promissory notes, due 1981 with institutional investors. Proceeds, beginning the first quarter of 1958, are to be applied to its expansion program which will increase ingot capacity at Fontana plant from 1,536,000 tons to 2,213,000 tons annually and to increase finished steel capacity such as tin plate, steel plate, and structural steel.

August 8

▲ Ore production was halted by the Oliver Iron Mining division of the United States Steel Corp. because of inability to get the ore in transit due to the tie-up of the 58-boat fleet of the U. S. Steel's Pittsburgh Steamship Division. The stoppage was occasioned by two maritime unions attempting to attain recognition as bargaining agents for crewmen.

August 9

▲ Shareholders of Newport Steel Corp., a Merritt-Chapman & Scott Corp. subsidiary, approved sale of the company's assets to Acme Steel Co., for $16,450,000. Acme plans a 400,000-share public stock offering and a loan to finance the transaction.

▲ Keystone Steel & Wire Co. and subsidiaries reported sales of $118,291,096, net profit of $10,080,391, and earnings per share of $5.38 for the fiscal year ended June 30, 1956 compared with sales of $101,380,689, net profit of $9,504,323, and earnings per share of $5.07 for the fiscal year ended June 30, 1955.

▲ Employment in July, 1956 rose to 66,700,000 jobholders an increase of 152,000 over last month and 1,600,000 over July, 1955. Government statistics showed unemployed totaled 2,800,000 in July, down 94,000 from June 1956, but 362,000 higher than in July, 1955. The unemployment figures do not include workers on strike.

▲ The Commerce Department reported that stocks of manufacturing, wholesale and retail firms at the end of June, 1956 were valued at $85,200,000,000, lower by $600,000,000 than May, 1956, but $6,900,000,000 higher than a year ago. On a seasonal adjusted basis, inventories increased an estimated $500,000,000 during June.

▲ Net sales of $76,416,044 were reported for the quarter April 1, to June 30, 1956 by Crucible Steel Co. of America with net earnings amounting to $4,405,828 or $2.44 per share, compared with net earnings of $4,036,579 or $2.24 per share for the same period in 1955.

▲ F. W. Dodge Corp. reports that contract awards for future construction during July in the 37 states east of the Rockies totaled $2,148,559,000, 5 per cent below July, 1955. Contract for future homes construction fell to $757,919,000, 21 per cent below July, 1955.

August 10

▲ In June imports into the U. S. totaled $1,000,000,000, 5 per cent less than May, but 10 per cent higher than in June, 1955, reflecting decreased American buying abroad of textiles, metals, and residual fuel oil. The figure for the first six months of 1956 equalled $6,300,000,000, or $800,000,000 over the 1955 period.

▲ Republic Steel Corp. announced an $8,000,000 expansion program at Canton and Massillon, Ohio to increase its output of titanium ingots and alloys to 12,000,000 lb yearly.

August 13

▲ The AISI reports that the operating rate of the steel industry for the week of August 13 is scheduled at 85.5 per cent of capacity. This is equivalent to 2,106,000 tons compared with 1,415,000 tons last week and 2,176,000 tons one year ago. Index of production for the week is 131.1.

August 14

▲ The Commerce Department reported that the national output of goods and services for the second quarter of 1956, on an annual rate, reached $408,300,000,000, up $20,900,000,000 from the second quarter pace in 1955, and $4,900,000,000 over the first quarter of 1956.

▲ U. S. exports in June, 1956 as reported by the Commerce Department were valued at $1,686,700,000, down $13,200,000 from May, 1956.

▲ Frank Rackley, president of Jessop Steel Co., reported that a plan for Jessop to acquire Green River Steel Corp., Owensboro, Ky., has been approved "in essence" by directors of both companies.

August 15

▲ A new wage agreement was signed by the Independent Steelworkers Union and the Weirton Steel

Co. for a 3-yr period, effective July 1, 1956 to June 30, 1959. Average straight time hourly rate increase in the first year is 10.6 cents per hr, second year an increase of 9.3 cents per hr and in the third year 10.6 cents per hr. An increase of 7½ cents per hr basic wage and an increase in increments between job classes above Job Class 2 of 3/10 of a cent follows immediately. Employment costs will be increased approximately 52.2 cents per hr over the 3-yr period.

August 16

▲ Armco Steel Corp. reported net profit for the quarter ending June 30, 1956 of $17,418,448 equal to $1.60 per share compared to net profit of $15,331,-441, or $1.45 per share in the same quarter, 1955. Sales for these quarters were $204,667,132 and $174,748,027 respectively.

August 17

▲ The Aluminum Association reported primary production of aluminum during July totaled 303,248,010 lb in comparison with 291,452,517 lb in June, 1956 and 265,337,163 lb in July, 1955.

August 20

▲ The AISI reports that the operating rate of the steel industry for the week of August 20 is scheduled at 95.1 per cent of capacity. This is equivalent to 2,340,000 tons compared with 2,154,000 tons one week ago and 2,186,000 tons one year ago. Index of production for the week is 145.7.

▲ The Industrial Heating Equipment Assn. reported that orders for industrial furnaces during July amounted to $4,140,163 compared with $4,338,092 a year ago. Orders for induction and dielectric heating equipment in July, 1956 amounted to $995,601, a drop of 30 per cent from the total of $1,417,356 for this same month last year.

▲ According to unaudited figures released by the Colorado Fuel & Iron Corp., net income for the fiscal year ended June 30 amounted to $16,662,653 or $4.74 per share, compared with net income of $10,887,163 or $3.79 per share for the previous year.

▲ Deliveries of new domestic freight cars in July totaled 5344 cars compared with 5550 in June, 1956 and 2192 in July, 1955. Orders in July totaled 2642 compared with 2859 in June. Backlog of cars on order as of August 1, stood at 126,194 cars.

▲ Coke prices were upped by metallurgical coke producers $2.00 per net ton.

▲ The Commerce Department reported that personal income for 1955 reached $303,000,000,000, exceeding 1954 total by $19,000,000,000. Personal income for the first six months of 1956 rose to an annual rate of $320,200,000,000, compared to the rate of $299,500,000,000 for the same period in 1955.

▲ Foreign investments by Americans rose to $29,-000,000,000 in 1955, an increase of $2,400,000,000 over 1954 according to the Commerce Department.

August 21

▲ The Bureau of the Census reports shipments in May 1956 of iron and steel castings equalled 1,506,-000 short tons, which was 3 per cent above April, 1956, but down 2 per cent from May, 1955.

August 23

▲ Commerce Department statistics reveal that cash dividend payments by corporations in July, 1956 amounted to $732,000,000, this compares with $669,000,000 in 1955. For the first seven months of 1956 the total was $6,100,000,000, 15 per cent higher than the comparable 1955 period.

▲ U. S. Private investments abroad earned a total of $3,100,000,000 in 1955 which is approximately 20 per cent higher than in 1954 as reported by the Commerce Department.

August 24

▲ Resistance Welder Manufacturers Assn. reported that shipments by its members in July, 1956 totaled $5,500,000, and new orders received during July amounted to nearly $3,500,000.

August 27

▲ The AISI reports that the operating rate of the steel industry for the week of August 27 is scheduled at 96.5 per cent of capacity. This is equivalent to 2,376,000 tons compared with 2,359,000 tons one week ago and 2,255,000 tons one year ago. Index of production for the week is 147.9.

▲ American Can Co. announced that can production in the United States amounted to 18,700,000,000 containers for the first half of 1956, an increase of 1,600,000,000 over the comparable period in 1955.

▲ The Cost of Living Index as compiled by the Bureau of Labor Statistics rose 0.7 per cent in July, 1956 to a "high" of 117 per cent of the 1947-49 average.

▲ The AISC reported bookings for July 1956 of 288,166 tons compared with 337,230 tons in June, 1956 and 369,414 tons in July 1955. Shipments in June, 1956 totaled 165,470 tons compared with 284,719 tons in June, 1956 and 219,444 tons in July 1955. Backlog at the end of July totaled 2,903,-725 tons.

August 28

▲ A $4,500,000 electrolytic zinc plating line will be built by Republic Steel at its Cleveland plant, having a monthly capacity of galvanized sheets of about 10,000 tons.

August 29

▲ The Office of Defense Mobilization was requested to grant fast writeoffs for tax purposes on $273,800,-000 of proposed steel plant facilities. United States Steel listed 6 projects totaling $208,600,000, Youngstown Sheet and Tube a $24,400,000 expansion and Inland Steel filed four applications for $40,800,000. The agency has closed its expansion goals for the steel industry but the applications were presumably filed in the hope that the program would be reopened.

▲ A $700,000,000 budget surplus was forecast by the Eisenhower Administration for the fiscal year ending June 30, 1957, in its mid-year budget review. On January 30, 1956 a surplus of $400,000,000 was predicted for the year ended June 30, 1956 but the surplus realized amounted to $1,800,000,000. The new budget estimate equalled $69,100,000,000 a boost of $4,000,000,000, and half of the increase was for increased farm benefits, revenues were $69,800,000,000, up $4,300,000,000.

August 30

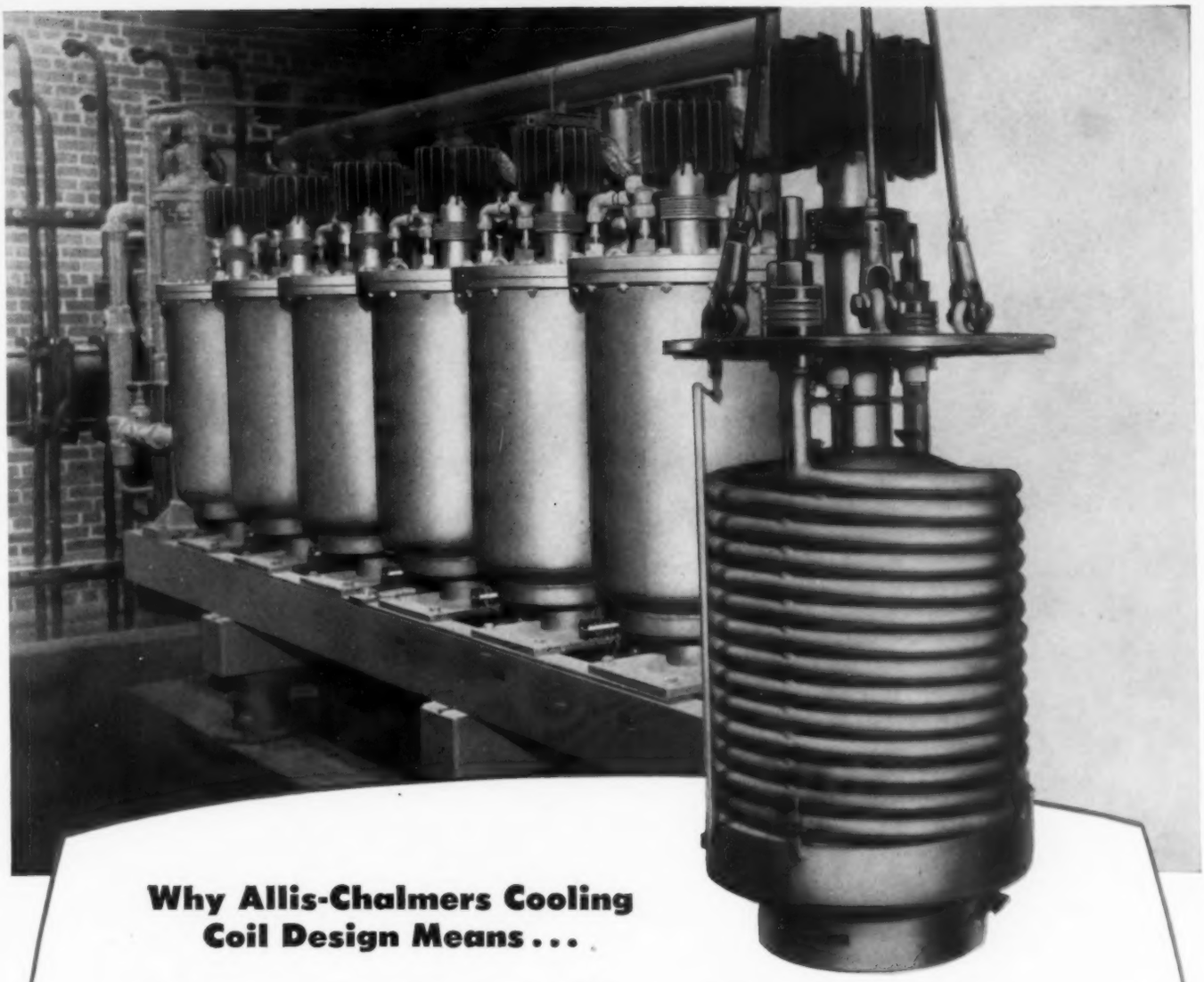
▲ Steel scrap asking prices in the Chicago area were raised $1.00 per ton to $60 for No. 1 industrial steel scrap, with similar advances on other grades.

▲ Olin Mathieson Chemical Corp. and Revere Copper and Brass formed the jointly owned Olin Revere Metals Corp. The new company will operate a plant to be built near Clarington, Ohio which will produce 180,000 tons of primary aluminum annually.

August 31

▲ Lehigh Portland Cement Co., Allentown, Pa., raised cement prices 15 cents a barrel to $3.20 effective in the fourth quarter and applying at '6 of the company's 14 plants.

▲ The Agricultural Department reported that farmers' assets rose to $170,100,000,000 in 1955 compared with $166,500,000,000 in 1954; debts climbed to $18,800,000,000 from $17,700,000,000.



Why Allis-Chalmers Cooling Coil Design Means . . .

Better Rectifier Operation

More Efficient Heat Transfer results from internal cooling coil. The steel coil surrounds active parts, offering more cooling surface and better heat transfer than other types. Unit maintains more uniform temperature and mercury vapor pressure.

Simplified Maintenance results from Allis-Chalmers unique unit construction. All active components are attached to the anode plate for easy withdrawal, dismantling, and re-assembling — as illustrated above.

Positive Arc Barrier is formed by the cooling coil, which is insulated from the tank. The main arc is confined within the coil, preventing arc transfer to the tank.

Years of Operation in hundreds of installations have proved the reliability, ease of operation, and simplified maintenance of Allis-Chalmers mercury arc rectifiers. You can get complete information at your nearby A-C office, or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin.

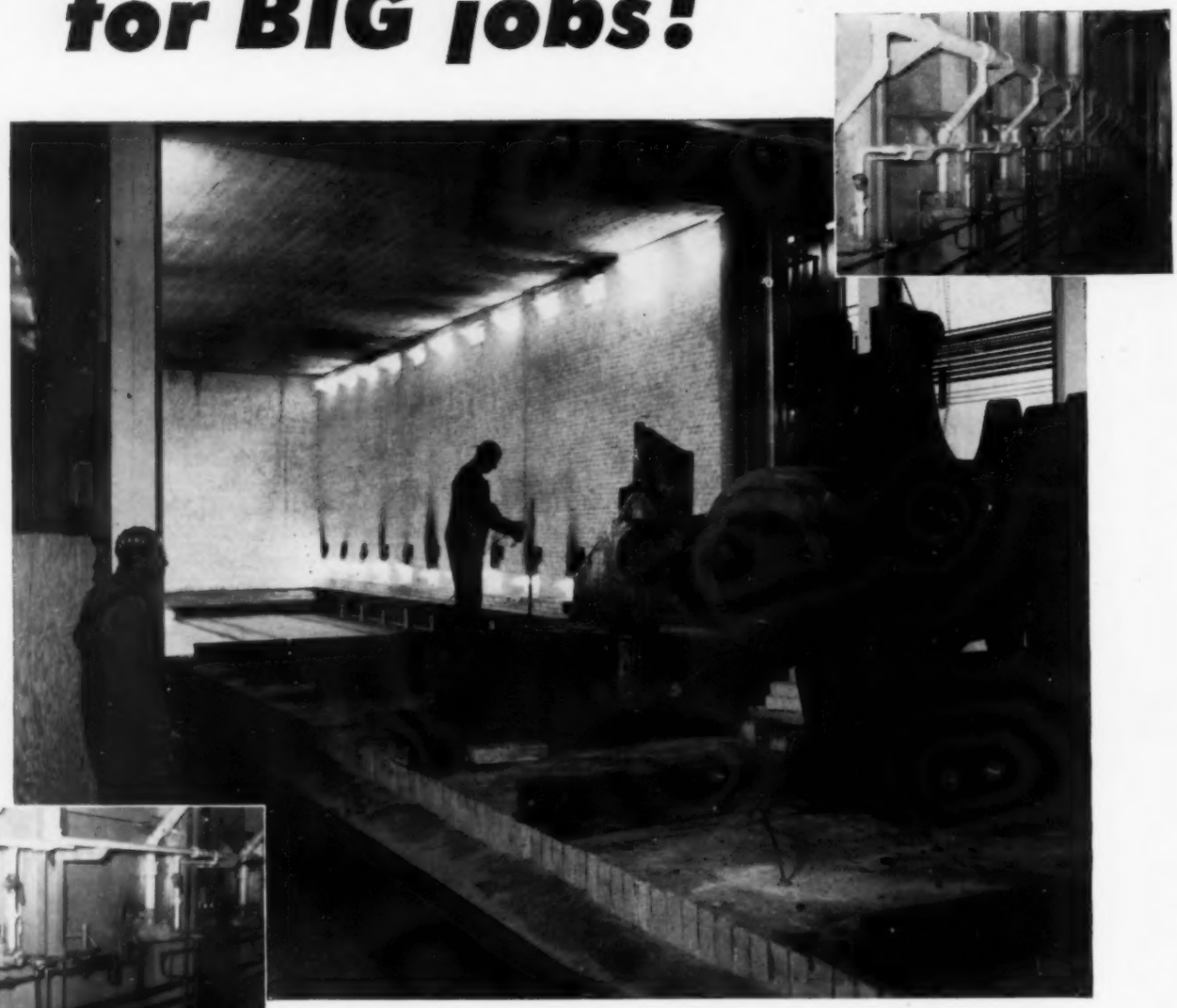
LIVE BETTER ELECTRICALLY

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

A-5084

uniform HEAT for BIG jobs!



at morgan engineering—alliance, ohio

This 52' x 21¼' x 17½' high car bottom furnace was designed by Morrison Engineering to stress relieve heavy weldments. The furnace is available for use by other firms on a subcontracting basis. It has the second largest car bed area of any such furnace in the world.

Imagine getting a **uniform heat** throughout a 250,000 pound load of steel with 3" to 10" thick sections in such a huge furnace! 48 North American No. 223-4 Dual-Fuel Burners do the trick. These burners, arranged in 4 banks and 3 zones, can burn 250 gallons of oil per hour, releasing 33 million Btu. They maintain a stable fire even when operating with a large amount of excess air to attain good temperature uniformity.

All the air is supplied by a North American Turbo Blower. North American pilots, valves, and Ratiotrols provide a safe, effective control system.

for additional information consult your local n. a. engineer or write for bulletin 223

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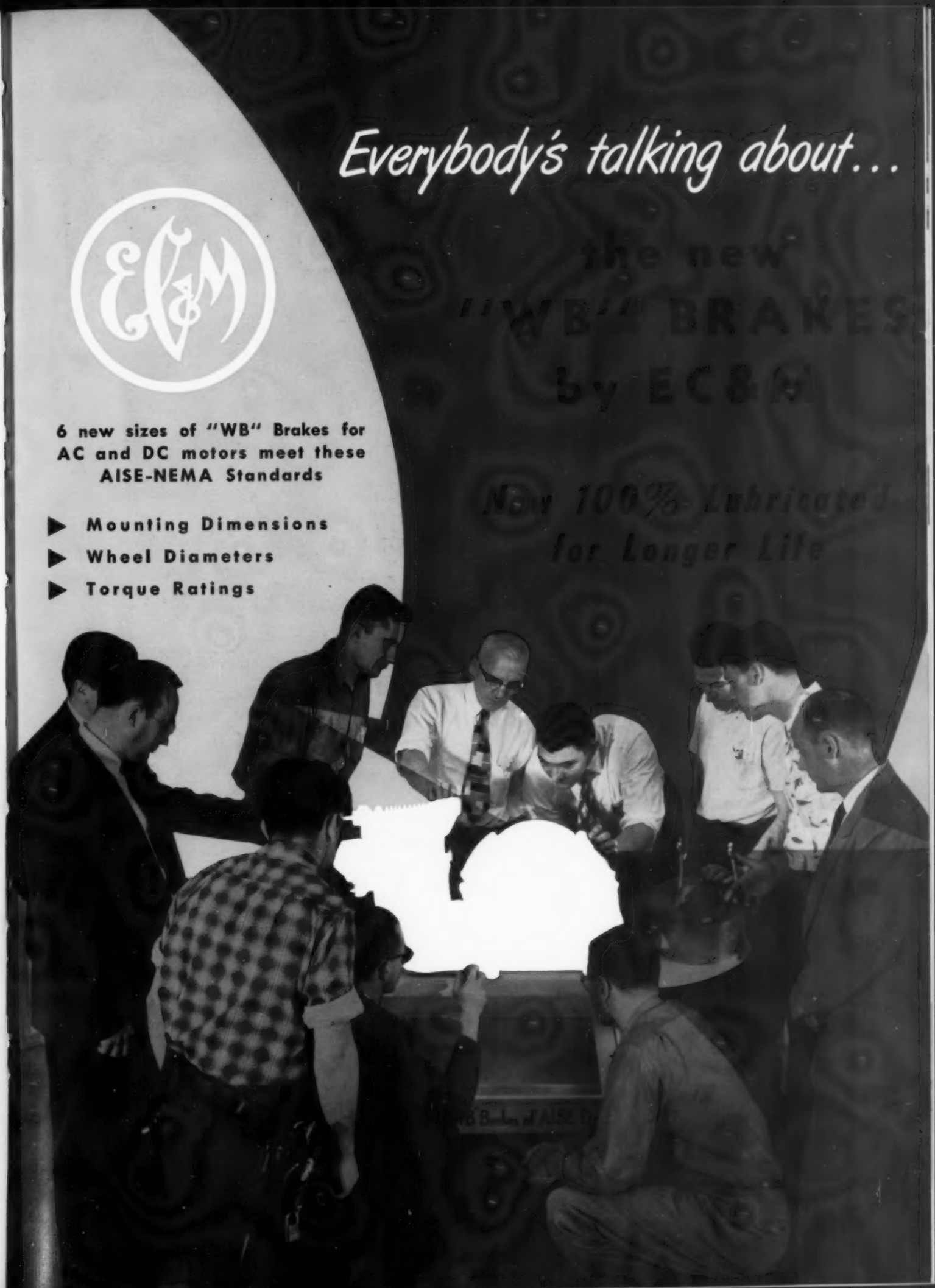

Everybody's talking about...
the new
"WB" BRAKES
by ECB&M
6 new sizes of "WB" Brakes for AC and DC motors meet these AISE-NEMA Standards
▶ Mounting Dimensions
▶ Wheel Diameters
▶ Torque Ratings

these improvements m
EASIER TO MAINTAIN.

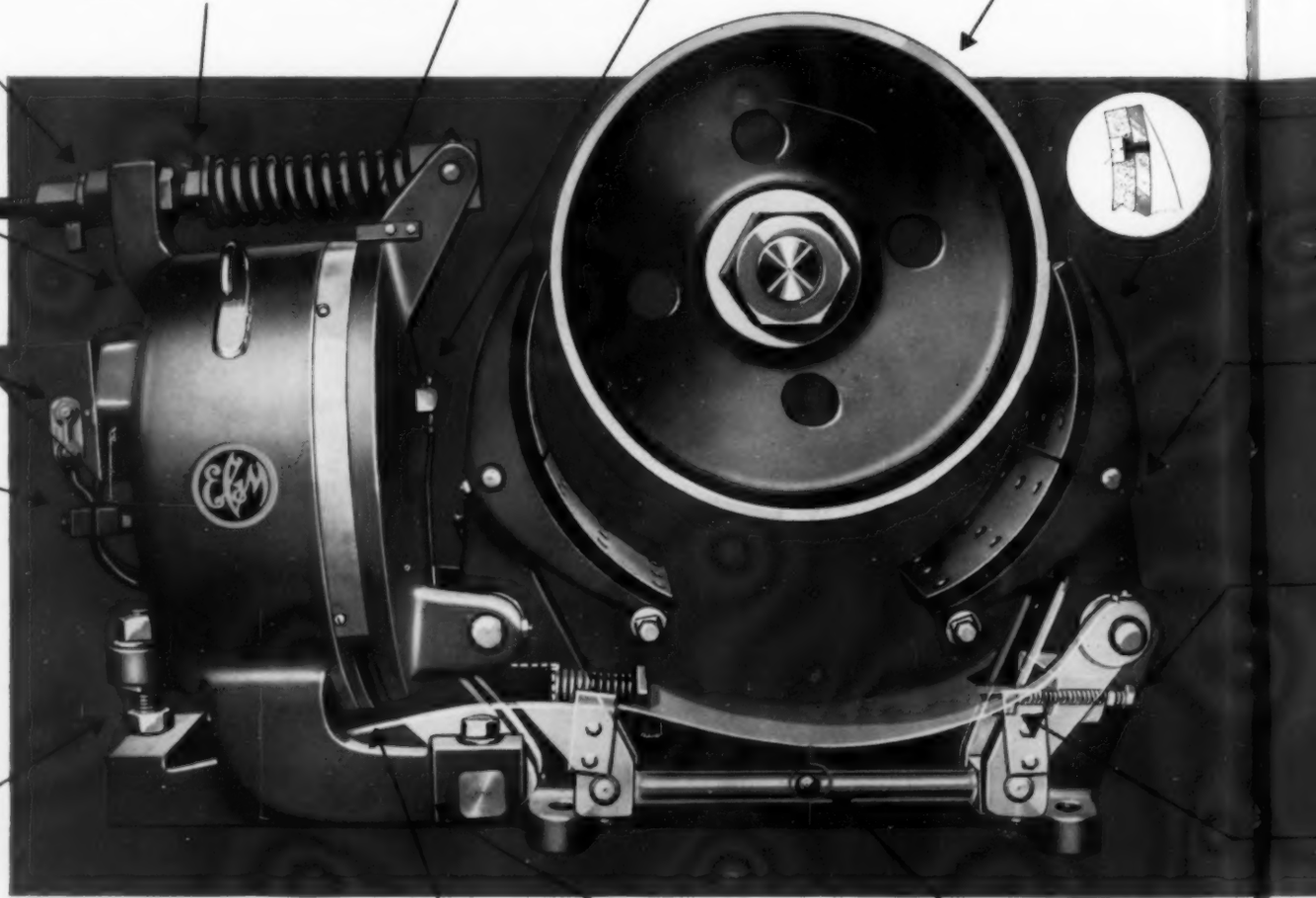
Manual release is standard on all sizes of these AISE-NEMA WB Brakes.

Bronze adjusting-nut on torque-spring rod has fine pitch threads for easier and closer adjustment.

Armature air-gap indicator shows visually when adjustment is needed to compensate for brake-lining wear.

100% - lubricated forces dirt out, all bearings alemite-lubricated.

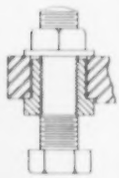
ECAMITE wheels are furnished as standard on all "WB" Brakes.



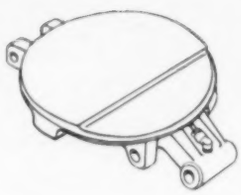
Magnet-case remains stationary and contains unit, armored coil.

Coil leads with solderless connectors under protective shield. Conduit connection box is optional.

Cable clamps for customer's incoming leads.



Single adjustment for brake lining wear. Adjusting-nut screws into stainless steel threaded bushing in magnet-case. This gives longer threaded path for greater bearing surface — easier adjustment — only single wrench required. Nut on top locks against machined surface.



Armature-face recessed at bottom allows dust to fall free — prevents clogging.

Magnet-case removable as a unit without disturbing remainder of brake.

Connecting lever remains below the brake wheel and is of tubular construction. Alemite fitting (on both sides) permits greasing four bearings from this one fitting.

ARMORED COIL CONSTRUCTION

WB Brake coils . . . protected by a steel enclosure, permit quick coil removal. After vacuum-impregnating with No. 371 polymerizing varnish and baking, coil is sealed in its protective enclosure with No. 372 Epoxy compound. This compound does not soften, but holds the coil securely against movement.

s) make the new "WB" brakes

N. . . LONGER LASTING!

Molded brake blocks, riveted securely in place, are made from an improved material having a higher coefficient of friction. Permissible wear is ⅛" on the smallest size to 7/16" on the largest size.

Fixed bearing-pins locked with stainless steel setscrews reduce number of lubrication points.

This adjustment equalizes clearance of both shoes.

Hardened steel camrails retain clearance between shoes and wheel with brake released.

These new EC&M "WB" Brakes are built to AISE-NEMA standards. The basic principles which made "WB" Brakes the outstanding brake for heavy mill service have not been changed. The new design includes several improvements making EC&M "WB" Brakes even longer lasting and easier to maintain. These improvements are:

1 — 100% lubrication . . . for longer life, for freedom of operation by forcing dirt out of bearing surfaces.

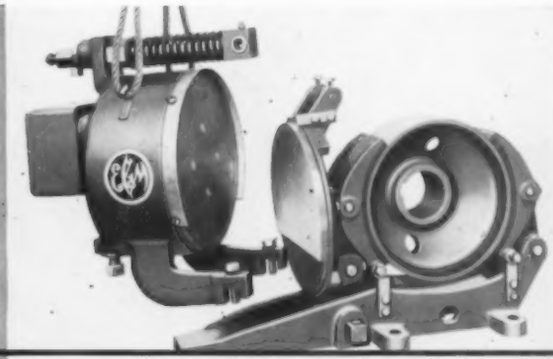
2 — Recessed armature . . . eliminating pocket for dust collection.

3 — Single wrench adjustment for brake-block wear . . . restores air-gap to normal, adjusting-nut has fine pitched threads.

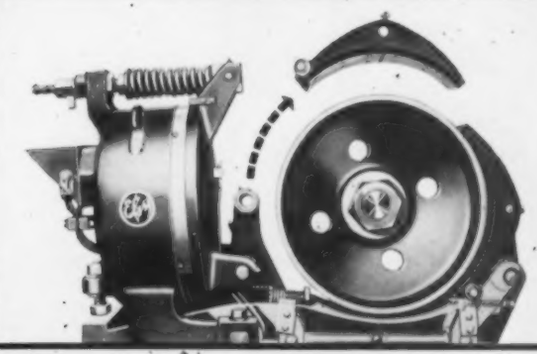
Remaining unchanged because of their proven acceptance and time-saving advantages are these features:-nothing over the brake wheel, manual release, single adjustment for lining wear, stationary magnet and sturdy 2-shoe construction.

These new EC&M "WB" Brakes are available with series and shunt coils for d-c service, and are supplied for rectifier-operation on a-c circuits. For LONG-LIFE Brakes, specify "WB" Brakes by EC&M.

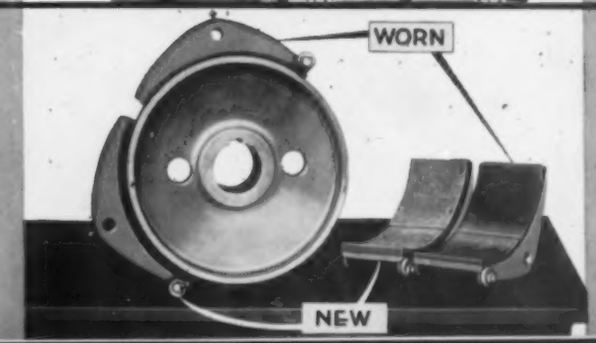
SIMPLIFIED MAGNET REMOVAL
Maintenance men appreciate the time-saving construction that makes coil changing a simple procedure. The magnet case can be swung away without disturbing the remainder of the brake. A coil can be replaced quickly or a complete new magnet installed in a matter of minutes.

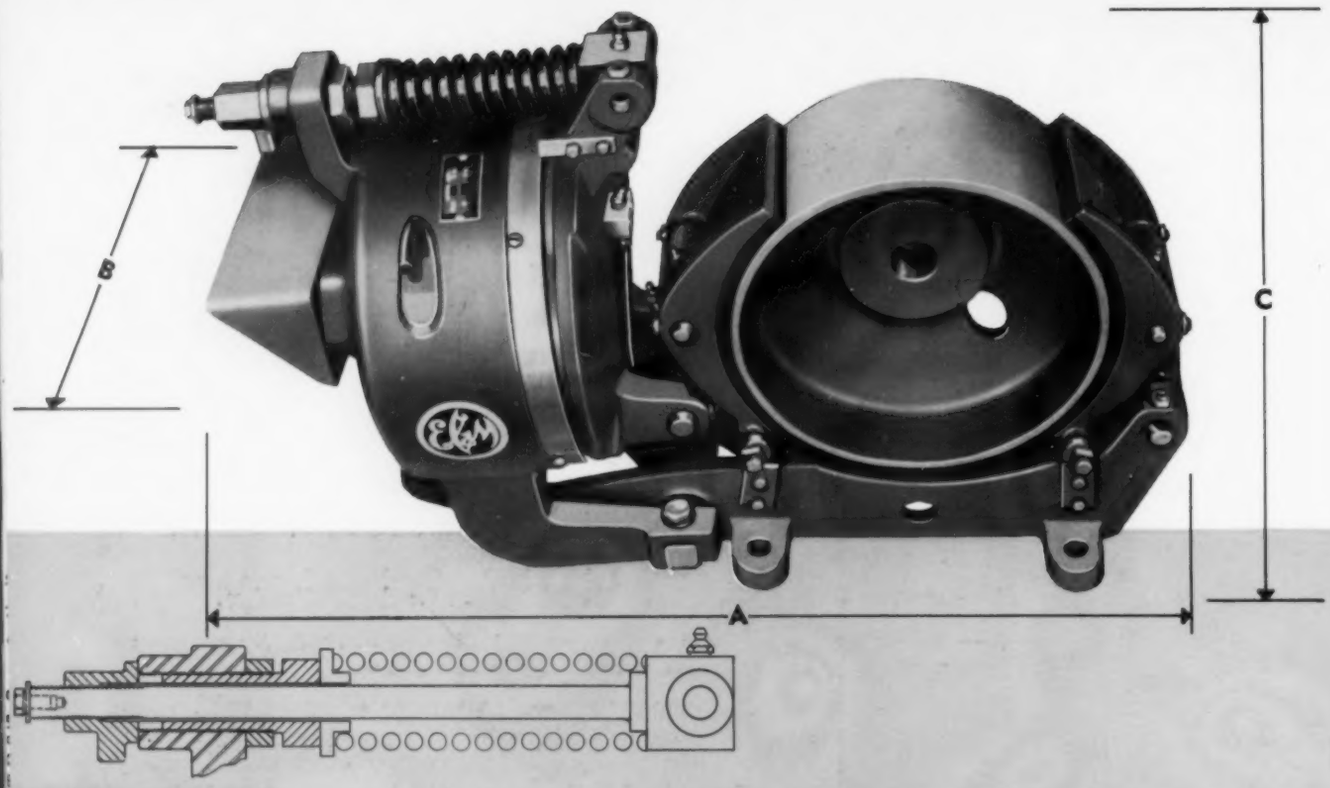


SHOES AND LINERS EASILY REMOVED
With shoe bearing-pins slipped out, shoes slide up on top of the wheel easily to permit worn brake-linings to be replaced. This has been standard construction with "WB" Brakes for years.



ACCURATELY FORMED RENEWABLE BRAKE BLOCKS
WB Brake Blocks retain their frictional quality longer than any other braking material. They are accurately formed so that new blocks fit the arc of the wheel and shoe surface as accurately as the original block.

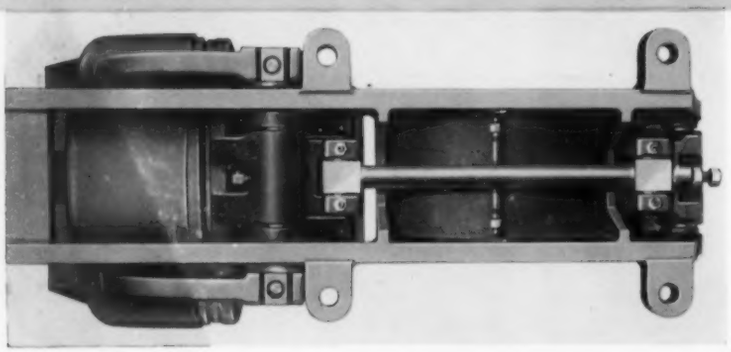




NEW OPERATING SPRING CONSTRUCTION

Operating spring force transmitted directly to magnet armature. Guide rod, threaded only at outer end under manual release (bronze) nut, is under tension only when brake is manually released. Brake torque is adjustable by a bronze nut threaded into the magnet-lug. Fine pitch threads permit closer and easier torque-adjustment. A jam-nut locks the setting.

Brake Size (Wheel Diameter)	600-Series Motor size	BRAKE TORQUE RATINGS in Lbs. Ft.				Approximate Outline Dimensions in Inches		
		Series-Wound Brakes		Shunt-Wound Brakes				
		½ hour Rating	1-hour Rating	1-hour Rating	Continuous Rating	Length "A"	Width "B"	Height "C"
8" WB	402 602	100	65	100	75	24¼	9¼	13½
10" WB	603 604	200	130	200	150	27¼	10¾	16⅜
13" WB	606 608	550	365	550	400	34¾	13¼	20⅛
16" WB	610	1000	650	1000	750	38⅜	15½	22¾
19" WB	612 614	2000	1300	2000	1500	45¾	18½	26½
23" WB	616 618	4000	2600	4000	3000	55⅜	21⅞	31⅜



Bottom view of new "WB" Brake showing tubular connecting lever for lubricating bearings at both ends from one alemite-fitting. The brake can be mounted either right or left hand, and the lubrication may be applied from either side through an opening in the brake frame.

EC&M "WB" Brakes have long been known for their fast response in releasing and setting. The fundamental short-stroke characteristic of these new "WB" Brakes which gives quick action has been proved on crane-hoists and hard-worked mill applications. Unit pressure between brake shoe and wheel remains at substantially the same low value as in the previous WB Brakes. These new EC&M "WB" Brakes, built to the AISE-NEMA Standards, are designed to give smoother operation . . . safer stops . . . and less maintenance. Specify EC&M Bulletin 1000 Type WB Brakes.

SQUARE D COMPANY
EC & M DIVISION • CLEVELAND 28, OHIO

new U.S. Steel Research Center installs LOEWY rolling mills

2-high reversing 21" by 30" hot mill for blooming, break-down and finishing. Maximum load 1,000,000 lbs.

4-high reversing 9" and 21½" by 16" cold mill for rolling flats. Maximum load 1,400,000 lbs. Both mills have front and rear tables with adjustable side guards.

Our rolling mills are built to individual requirements. We render complete services from planning to full operation. We build blooming mills, merchant mills, continuous billet and sheet bar mills, continuous strip mills, continuous merchant and wire rod mills, rail and structural mills, skelp mills, high-speed cold sheet and strip mills, high-speed foil mills, special mills and auxiliary equipment for steel, light metals, copper and brass. For bulletin 14002, write Dept. 217, Loewy-Hydropress Division, BLH Corporation, 111 Fifth Avenue, New York 3, New York.

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LOEWY-HYDROPRESS
BALDWIN-LIMA-HAMILTON

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MANSAVER GRABS

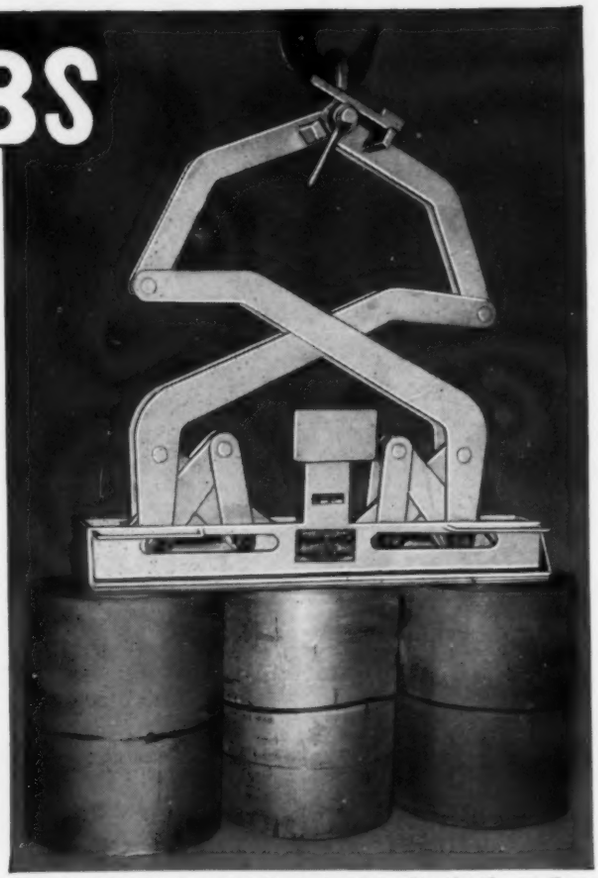
SERVING INDUSTRIES HERE AND ABROAD SINCE 1923

Mansaver Grabs are basically *Mansaver designs;* high quality products properly engineered for the purpose intended; sold at a price sufficient to assure the user a dependable and efficient mechanism as well as good engineering advice throughout its life.

The Mansavers shown here, built in this instance for handling coils of metal, constitute a case in point. They are entirely original designs, built to handle one, two or three coils. Fully automatic and entirely mechanical, these grabs were developed to answer constant requests from the steel industry for improved designs.

The solution of other problems has resulted in the widespread use of motor-driven Mansaver Grabs here and abroad, grabs which handle coils and sheets in spaces so small as to be unbelievable until seen!

Send for catalog of Mansavers—"Built to PREVENT ACCIDENTS and PRODUCTION DELAYS."



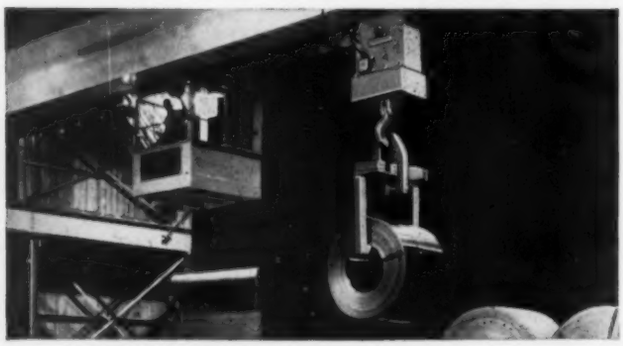
Style 1616-D—Has two sets of gripping jaws. Handles three coils, as shown, by gripping the two outside coils at the same time it grips the inside coil. Also handles single coils by double-rim gripping. Gripping pressure is maintained even with variation of rim thickness between the two sets of jaws. Fully automatic, and load is alternately gripped and released as grapple is raised and lowered.

At IRON & STEEL EXPOSITION

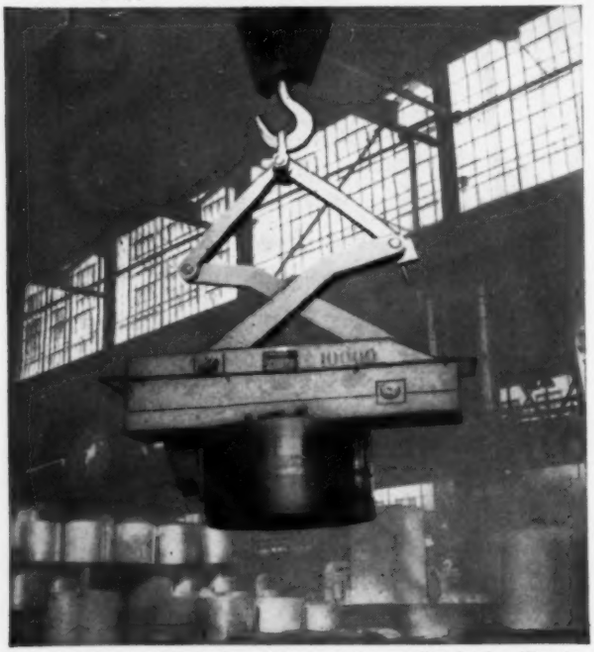
CLEVELAND, SEPT. 25-28

MANSAVER INDUSTRIES, Inc., 3116 East St., New Haven 11, Conn.

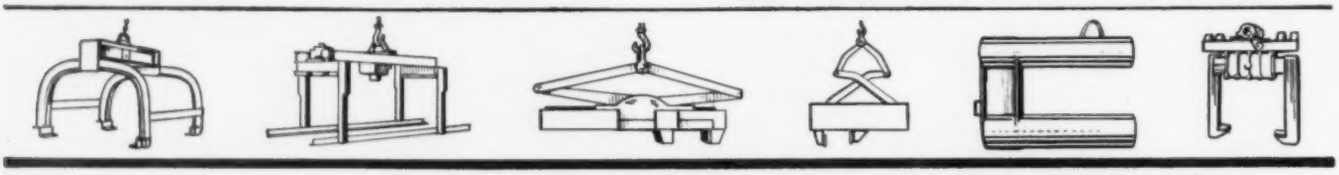
Branches and Factories in Foreign Countries



Style 1588 Mansaver Motor-Driven Crane Hook, permits 360° rotation in horizontal plane for use with hand or motor operated grabs. Shown here with Motor-Driven Mansaver Telescoping-Leg Coil Grab, Style 1418, in use in coil storage area ahead of continuous galvanizing line.



Style 1616-S—For single-rim gripping. (Also supplied for handling two coils.) One pair of gripping jaws, designed for long travel, accommodates wide range of rim thickness. High, uniform gripping pressure. Has Mansaver automatic holding device to alternately grip and release load as grapple is raised and lowered. Exceptionally rugged construction.



CONTINUOUS THERMAL PROCESSING...

more steel... improved quality!

A significant first in the steel industry has resulted from the recent installation of three new and identical annealing lines, each designed to deliver 20 tons of improved-quality silicon steel per hour.

This continuous annealing operation in a limited area created an unusual problem in control accuracy and reliability. Westinghouse MAGAMP* magnetic amplifier regulators form the heart of the control system . . . make this the first all-magnetic amplifier continuous annealing line. Westinghouse furnished complete electric equipment and furnaces for all three lines.

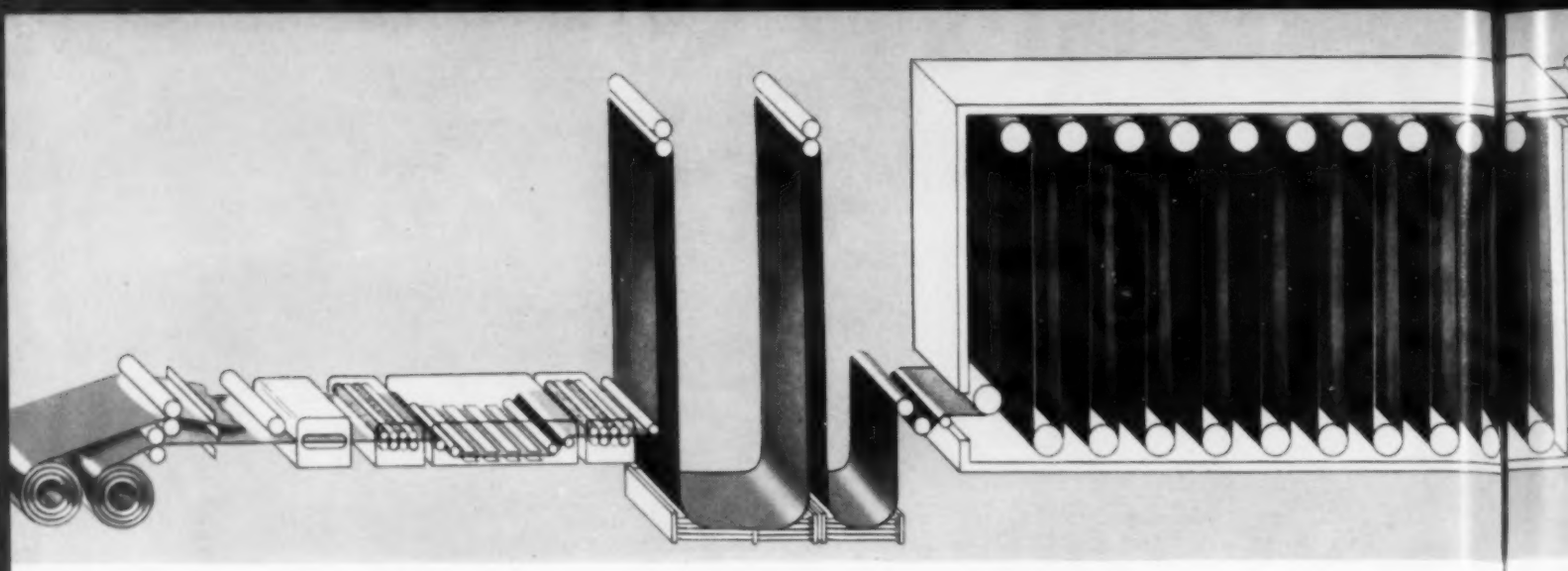
And . . .

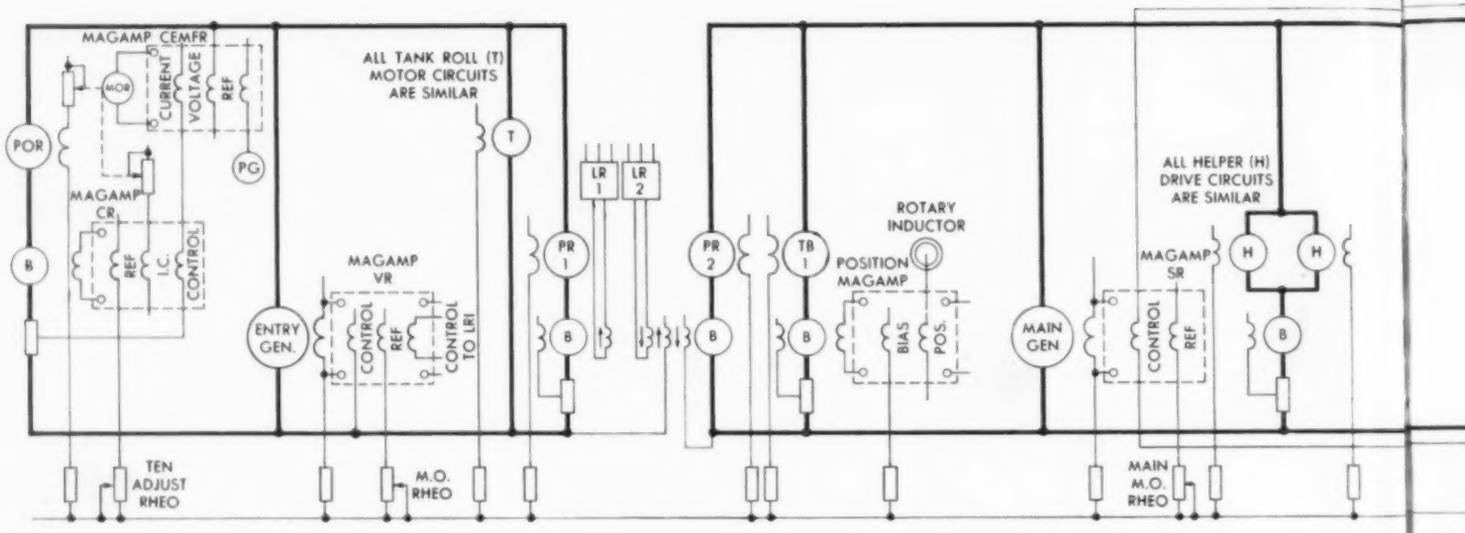
Here's another big development in the steel industry ———

*Trade-Mark

WATCH WESTINGHOUSE!

*WHERE **BIG** THINGS ARE HAPPENING **TODAY!***





Tin-plate annealing equipment designed for . . .

Process speeds beyond 2000 fpm, output 60 tons per hour!

Tin-plate annealing lines now being built will be capable of boosting output as much as 100% over existing continuous lines.

Continuous annealing lines are from 300 to 400 feet in floor length. Since the strip travels through many vertical passes, several thousand feet of tin plate are accommodated in the line between the pay-off and winding reels.

High-speed annealing operations like this demand the ultimate in coordination and reliability. Westinghouse motors, controls, furnaces and related equipment will help you handle speed and output up to and beyond 2000 fpm, 60 tons per hour—while maintaining precise quality standards. Moreover, Westinghouse accepts full unit responsibility for the electric and furnace equipment installed in your line.

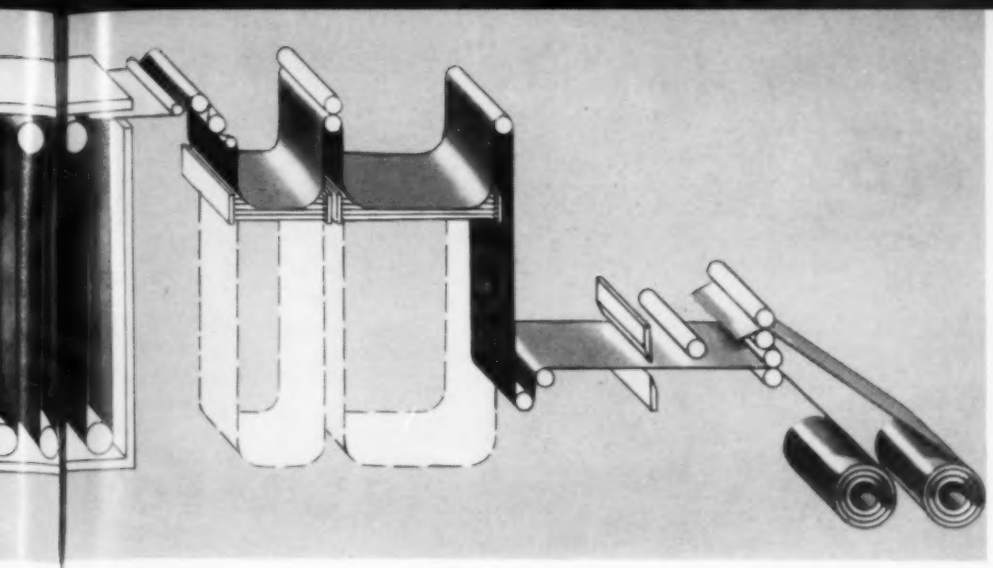
How Line Control Operates

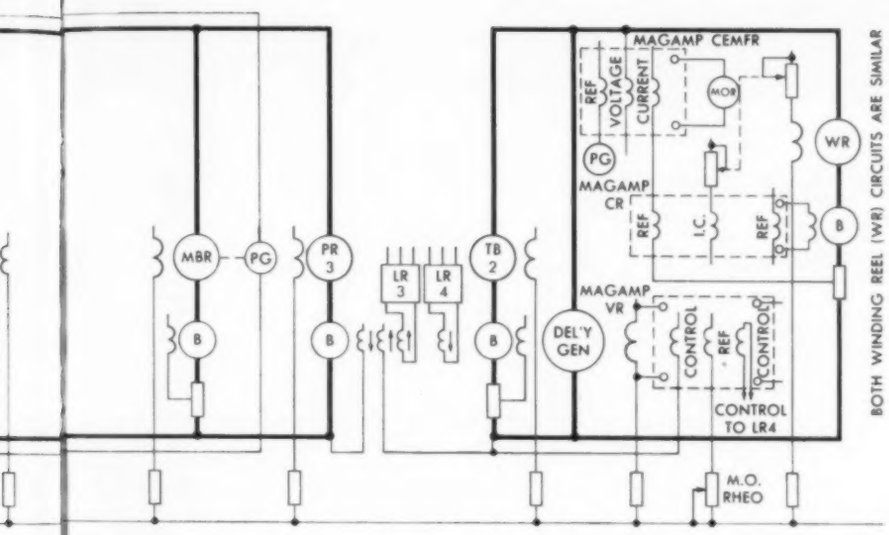
Westinghouse has many years of successful experience applying MAGAMP regulators to drive systems. Above diagrams show how Westinghouse MAGAMP regulators are applied in modern, continuous annealing lines.

MAGAMP speed regulator (SR) maintains constant speed through the critical annealing zone. Speed reference, set by main motor-operated rheostat (MOR), is

WATCH WESTINGHOUSE!

*WHERE **BIG** THINGS ARE HAPPENING **TODAY!***





balanced by the control winding fed from the pilot generator (PG) driven by the master bridle roll (MBR).

MAGAMP voltage regulators (VR) control the voltage of the entry and delivery generators assuring fast, even acceleration and deceleration and a minimum of loop disturbance during steady operation. Loop regulators set as verniers in controlling generator voltages.

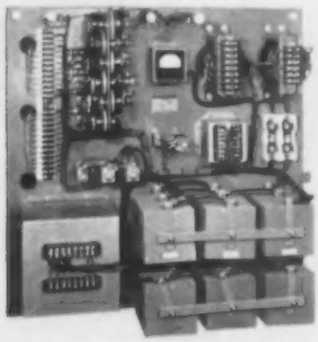
MAGAMP current regulator (CR) for booster, and MAGAMP counter-EMF regulator (CEMFR) for motor, work together so regulated tension is maintained by the pay-off reels (POR) and winding reels (WR). Inertia compensation (IC), proportional to accelerating loads, and stall tension signals are introduced through the (CR) circuits.

Photo-thyratron loop regulators (LR) provide modulated control of storage loops for smooth operation.

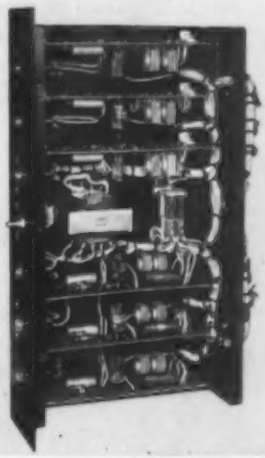
Machine characteristics are selected for best drive performance. Pinch roll no. 1 (PR-1), master bridle roll (MBR), and tension bridle no. 2 (TB-2), the pacesetters of their respective line sections, are shunt-wound for flat, speed-load characteristic. Helper drives (H) have high drooping characteristics which result in their developing only the power required to overcome their friction losses and inertia loads. Reel motors have high overload capacities suitable for accelerating the large coils which are now used in most mills.

MP-3044

Centralized line control reduces space requirements and provides ready accessibility for inspection.



Magamps bring outstanding precision, dependability to line control . . . no moving parts, brushes, commutators, bearings.



New Westinghouse fault finder monitors control circuits simultaneously, indicates faults instantly and makes trouble-shooting easy.

Westinghouse d-c motors perform efficiently under tough conditions. High starting torque ideal for high inertia loads.

Westinghouse continuous furnace anneals eight tons per hour of silicon steel at 184 fpm and stress relieves 20 tons per hour at 460 fpm.

Three ways Westinghouse furnaces match increased annealing speed

Westinghouse gas and electric furnaces meet the demands of today's high-speed thermal processing and annealing lines three ways:

Construction—furnace layout compensates for thermal expansion. Maximum accessibility provided for convenient replacement of burner and heating element panels and rethreading.

Temperature Control—Typical examples are: proportioning-type controls to regulate recuperative radiant tubes in gas-fired furnaces; Furnatron® regulators to maintain constant temperatures in electric furnaces.

Atmosphere—Westinghouse atmosphere generators provide controlled and protective atmosphere which maintains product quality at higher speeds. Strip is produced flatter, more uniform . . . surface is cleaner.

Westinghouse consulting, application and design engineers can speed equipment installation, eliminate problems right from the start. They help match correct products to the job, test them to assure proper operation.

From planning or problem, to design, installation and start-up . . . Westinghouse is at your service. An experienced Westinghouse team will work with your engineering staff and consulting engineers in setting up your thermal process line.

For your convenience . . . 38 manufacturing and repair service plants superbly equipped for repairing all types of electric apparatus . . . 34 renewal parts warehouses strategically located in industrial centers, open 24 hours a day.

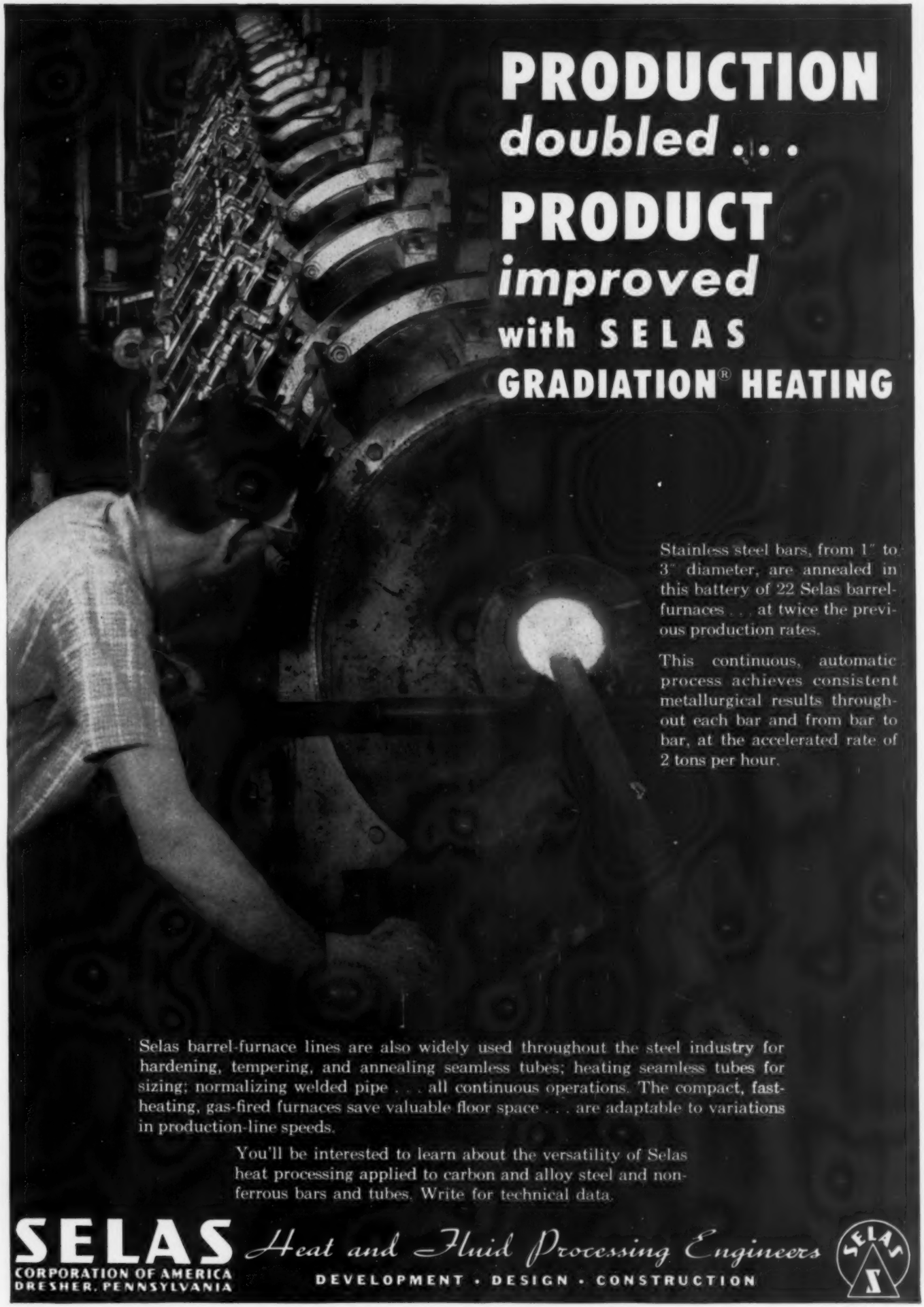
Contact your Westinghouse sales office for further details. Ask for a copy of B-6072, *Westinghouse Drives for Processing Lines.* Or write, Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pennsylvania. MP-3044

Completely self-adjusting, magnetic, d-c motor brake assures safer, more positive stops and starts. Maintenance and replacements minimized.

Westinghouse engineers help you plan installations like this compact a-c control center for fans, pumps and other auxiliary equipment.

WATCH WESTINGHOUSE!

*WHERE **BIG** THINGS ARE HAPPENING **TODAY!***



PRODUCTION *doubled . . .*

PRODUCT *improved* with SELAS GRADIATION® HEATING

Stainless steel bars, from 1" to 3" diameter, are annealed in this battery of 22 Selas barrel-furnaces . . . at twice the previous production rates.

This continuous, automatic process achieves consistent metallurgical results throughout each bar and from bar to bar, at the accelerated rate of 2 tons per hour.

Selas barrel-furnace lines are also widely used throughout the steel industry for hardening, tempering, and annealing seamless tubes; heating seamless tubes for sizing; normalizing welded pipe . . . all continuous operations. The compact, fast-heating, gas-fired furnaces save valuable floor space . . . are adaptable to variations in production-line speeds.

You'll be interested to learn about the versatility of Selas heat processing applied to carbon and alloy steel and non-ferrous bars and tubes. Write for technical data.

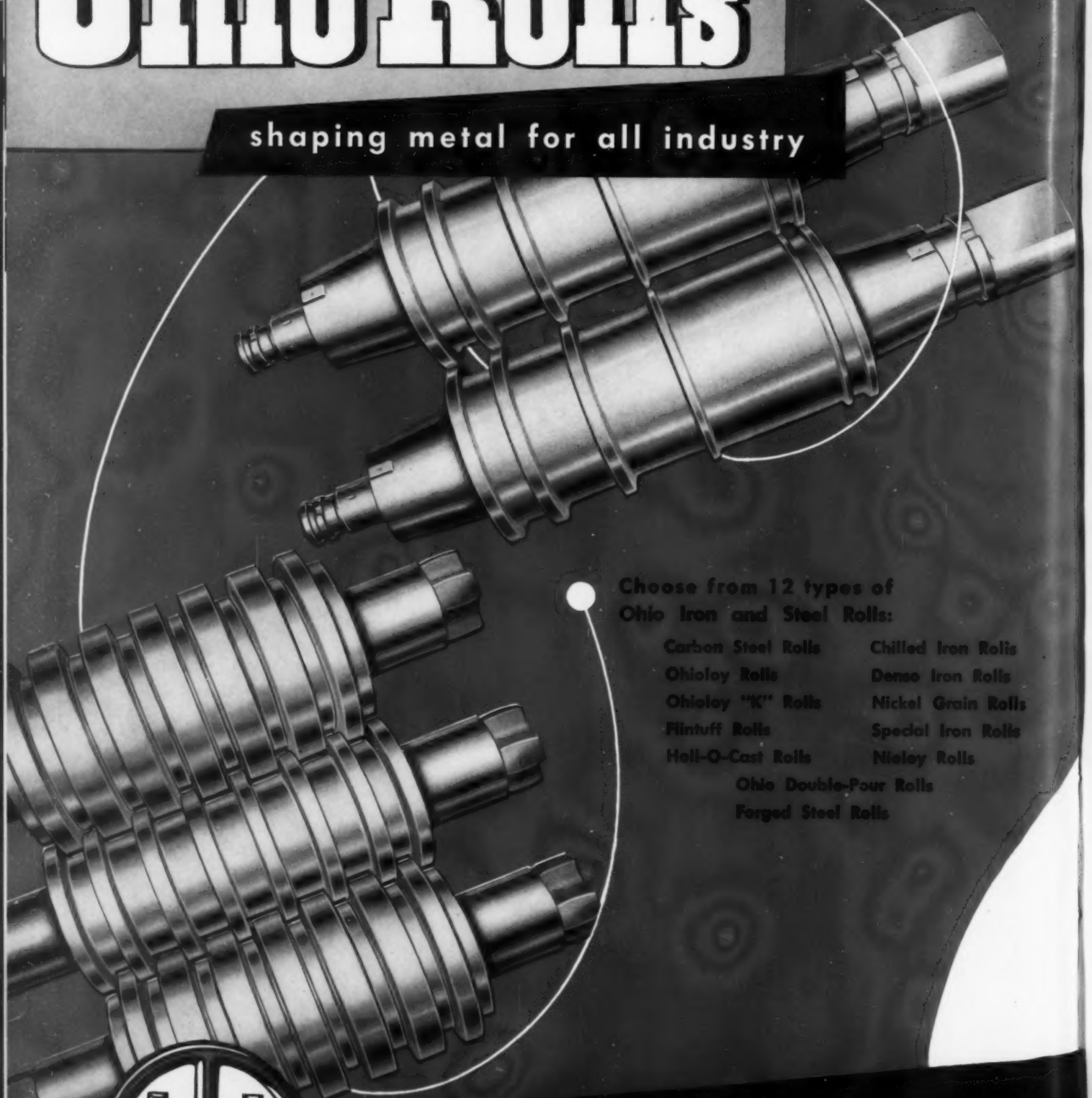
SELAS
CORPORATION OF AMERICA
DRESHER, PENNSYLVANIA

Heat and Fluid Processing Engineers

DEVELOPMENT • DESIGN • CONSTRUCTION

Ohio Rolls

shaping metal for all industry



Choose from 12 types of
Ohio Iron and Steel Rolls:

- Carbon Steel Rolls
- Ohioloy Rolls
- Ohioloy "K" Rolls
- Flintuff Rolls
- Holl-O-Cast Rolls
- Chilled Iron Rolls
- Denso Iron Rolls
- Nickel Grain Rolls
- Special Iron Rolls
- Nioloy Rolls
- Ohio Double-Pour Rolls
- Forged Steel Rolls

THE OHIO STEEL FOUNDRY CO.

LIMA, OHIO

Plants at Lima and Springfield, Ohio

Industry News...

EXPANSION OF TITANIUM FACILITIES IN CANTON AND MASSILLON ANNOUNCED BY REPUBLIC STEEL

▲ An $8,000,000 expansion of titanium melting, preparation, forging and laboratory facilities at Republic Steel Corp. plants in Canton and Massillon, Ohio, has been announced.

The program will increase Republic's ingot output of titanium and titanium alloys to approximately 12,000,000 lb a year. Products available will be bars, wire, forging billets, plates, sheets and strip.

Initial phase of the program already is in progress and is expected to be completed this autumn. The entire program is scheduled to be completed in the autumn of 1957. It is covered in large part by a certificate of necessity granted to Republic by the Office of Defense Mobilization permitting accelerated depreciation of the new facilities.

Virtually all the new facilities will be at Republic's South division plant in Canton. They will require approximately 100,000 sq ft of additional building space. However, bar rolling finishing facilities will be added at the Massillon steel plant to handle increased titanium production there.

Major facilities in the expansion are 12 vacuum double melt consumable electrode melting furnaces. Of these, eight will be first melt furnaces and four will be second melt furnaces.

Under the double melt method, which has become standard practice in the titanium field, titanium sponge and scrap are compressed to form an electrode that is melted in the first melt furnace to form an ingot. Ingots from first melt furnaces are welded together to form an electrode for melting in the second melt furnace. The resulting ingot is ready for skinning and rolling operations.

Because first melt furnaces provide an intermediate product, capacity is calculated only for the second melt furnaces.

Four of the first melt and two of the second melt furnaces are scheduled to be put into operation this autumn. The remaining furnaces to be constructed are expected to be in production next year.

The expansion will be made at Republic's Central Alloy District. The district plants in Canton and Massillon produce primarily specialty metals. All of Republic's stainless steel melting and titanium facilities are located in this district. It also produces a large share of Republic's output of alloy and heat-resisting steels.

In addition to the furnaces mentioned above, the following facilities will be installed: sponge and scrap processing equipment; electrode preparation equipment, including a 2500-ton press and a jig welder; pickling facilities; equipment for grit cleaning sheets; vacuum annealing furnaces and sheet handling facilities; a 3000-ton hydraulic forge press, two car-type heating furnaces and finishing facilities for forged products.

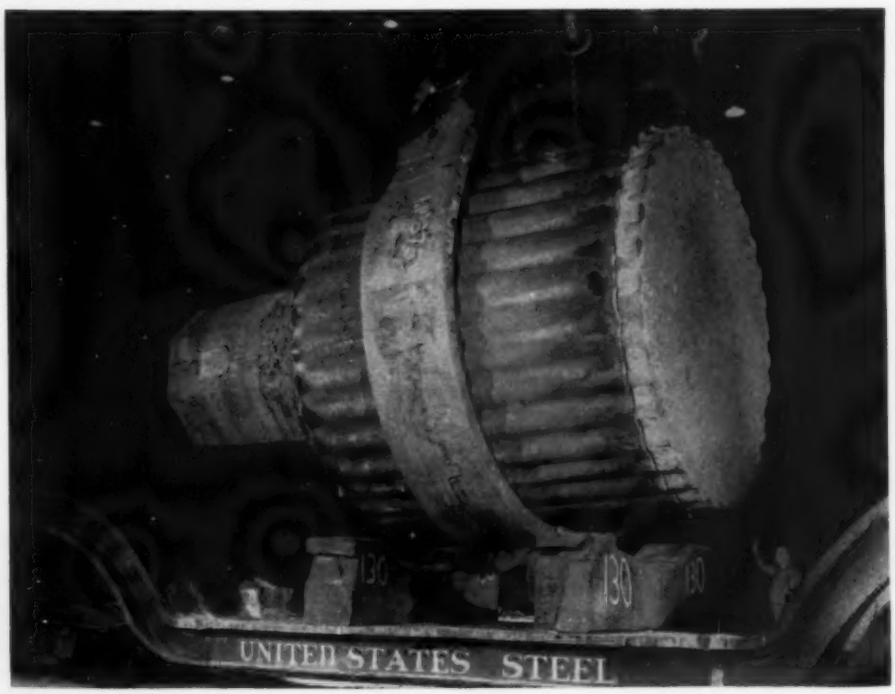
Titanium metallurgical and chemical research and testing facilities are being increased greatly. Miscellaneous items in the program include an addition to the office and service building, an extension to the primary electric power sub-station, extension to the water treating plant, an additional spray pond for cooling treated water, materials handling equipment and others.

At the Massillon steel plant an extension will be made to the present 12-in. bar mill. Bar finishing, straightening, cut off, annealing and heat-treating facilities will be installed.

In addition, existing rolling mills, heat-treating and finishing facilities, metallurgical equipment and other facilities in the district will be utilized for titanium wherever feasible.

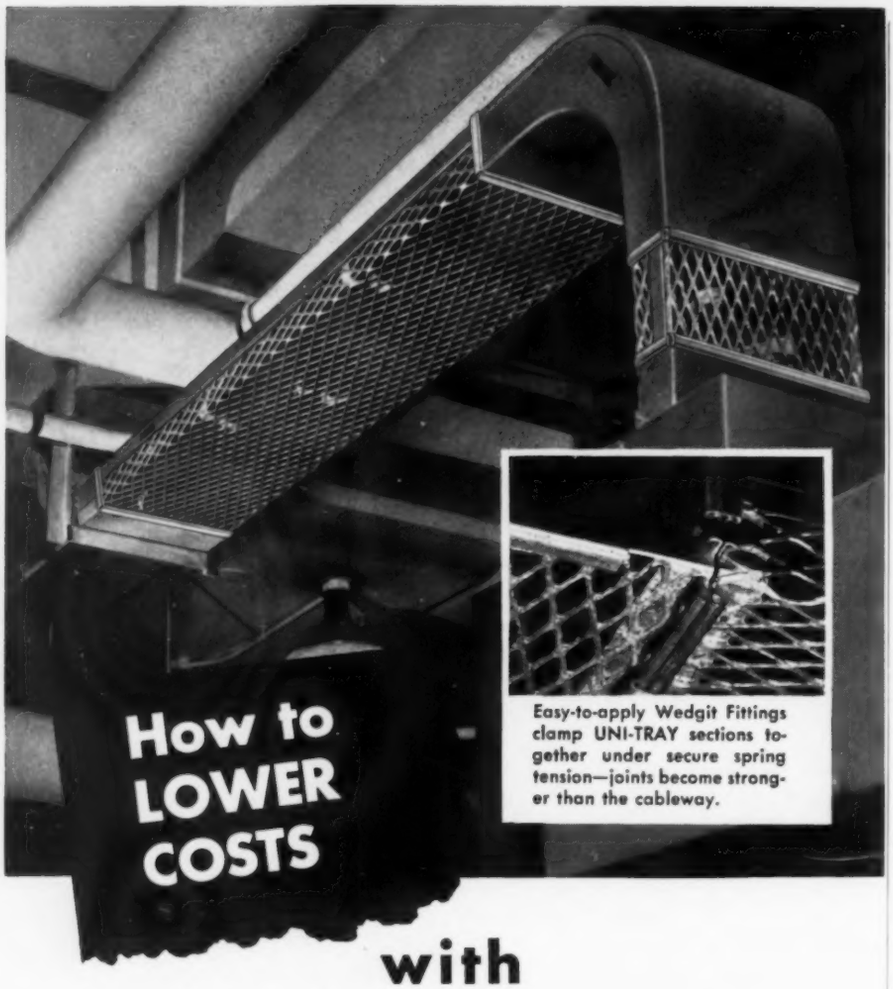
GIANT INGOT FOR SEAWAY PROJECT

This 516,560-lb ingot, one of the biggest ever cast at U. S. Steel's Homestead District Works, will be forged, heat treated and machined at the plant's forging division before shipment as a hydro-electric shaft for the St. Lawrence Seaway Project.



J&L WILL UTILIZE NEW REFINING TECHNIQUES

▲ Refining facilities costing more than $2,000,000 have been planned by Jones & Laughlin Steel Corp. to aid in the production of higher-quality coal chemicals. Esso Research and Engineering Co. has li-



Easy-to-apply Wedgit Fittings clamp UNI-TRAY sections together under secure spring tension—joints become stronger than the cableway.

with

UNI-TRAY Cable-Way

With Delta-Star's UNI-TRAY Cable-ways you reduce installation time up to 40% — substantially cutting cableway costs. Simply position the trays, then tap in Wedgit Fittings to connect sections. No bolts, pins or hinges to fit or tighten. UNI-TRAY Cable-way joints are assembled four times faster than with other type fittings.

Strong, lightweight expanded metal sections provide ventilation necessary for high current rating of cables — prevent collection of water and dirt. Continuous Wedgit contact areas provide excellent electrical contact for ground currents.

UNI-TRAY sections are available in hot-dip galvanized steel, with aluminum Wedgit fittings. Aluminum sections also available. A wide variety of shapes and sizes meet specific requirements.

Write for UNI-TRAY Publication No. 68 —or see your nearby Delta-Star representative.

HKP

DELTA-STAR ELECTRIC DIVISION

H. K. PORTER COMPANY, INC.

2437 Fulton Street • Chicago 12, Illinois

• District offices in principal cities

censed J & L to use a sulfur-removal process called "Hydrofining." Universal Oil Products Co. has licensed the steel firm to build a "Udex Process" unit for the final purification and removal of all remaining nonaromatic impurities. This process was originated by Dow Chemical Co. and further developed by Universal.

The combination of these two processes will purify the chemicals produced from all of J & L's by-product coke oven operations. The plants will be built at J & L's Aliquippa, Pa., Works. Construction is now under way and completion is scheduled early in 1957.

Jones & Laughlin officials commented that the decision to take the revolutionary step stems largely from more rigid specifications now imposed by customers of coal chemical aromatics as a result of numerous new developments in the utilization of these chemicals.

Consumption of these chemicals has risen rapidly. For instance, benzene production has increased from only about 30 million gallons a year in 1938—when the only source was coal—to more than 300 million gallons this year. Coal currently supplies about two-thirds of this volume, with the remainder coming from petroleum.

INDIAN PLANT TO USE OXYGEN CONVERTER

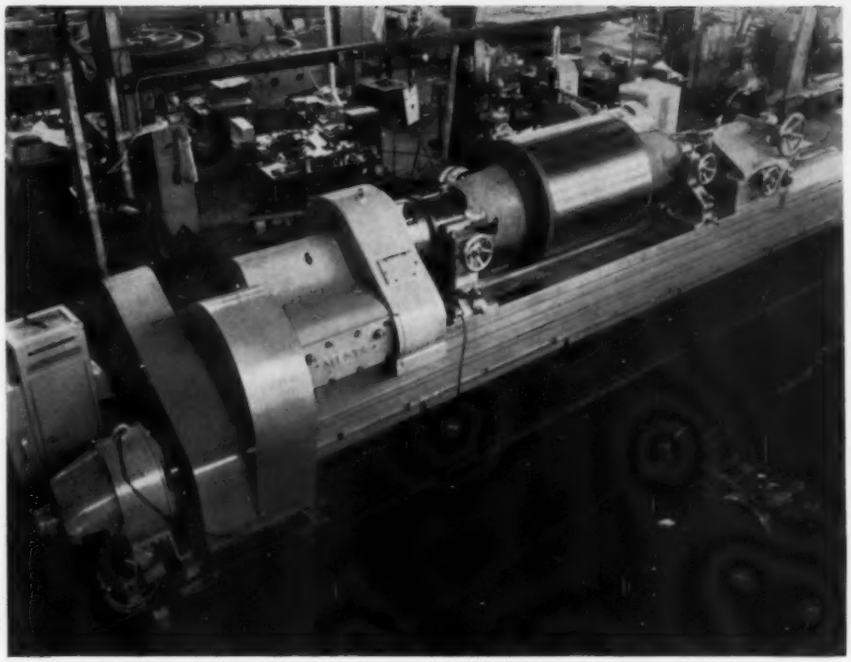
▲ Brassert Oxygen Technik A. G. of Zurich, Switzerland, announced that it has completed negotiations on a general license agreement with the Government of India which will extend the steel industry of that country through the use of the oxygen converter process.

The first general license in India will be issued to the Hindustani plant at Rourkela. Three quarters of the plant's planned 1,000,000 ton annual production will be made by the oxygen converter process.

TWO BLAST FURNACES BEING RELINED BY ARMCO

▲ The Bellefonte blast furnace at Armco Steel Corp.'s Ashland, Ky., Works is undergoing a complete relining.

J. M. Lobaugh, works manager, announced that the Arthur G. Mc-



Modifications by Simmons adapt this roll grinder to high-speed, high precision work

This 60-in. x 288-in. roll grinder underwent *Engineered Rebuilding* and extensive modernization at Simmons. A new drive eliminated vibration, making possible the grinding of large rolls to a fine mirror finish.

Other modifications: higher work speeds from increased HP, new coolant pump and filter unit, crowning attachment permitting crowning rolls for the full 288-in. range of machine, roll neck supports for larger rolls.

Your valuable equipment—used, abused, past its prime—can be returned to its original tolerances through Simmons *Engineered Rebuilding*. It can be updated to handle today's production through *modernization* . . . all at costs substantially under new tool outlays!

Simmons engineers will advise you on your own rebuilding, modernization, conversion, or special-application machine needs, at no obligation. Write or telephone today.

New issue available . . . THE SIMMONS WAY

Illustrated case histories in the new issue of THE SIMMONS WAY include the big Mesta above, boring mills, and other equipment recently rebuilt and modernized for major manufacturers. Write now for your copy.

Check these machines now available from stock

34-36 Hydromatic Cincinnati Miller

No. 2 Medart Bar Straightener

16′ x 2″ Sellers Pyramid Rolls

Morton Hydraulic Draw Cut Shaper

No. 5 Cincinnati H.P. Plain Miller

50-ton Lucas Forcing Press

48″ x 41′ American G.H. Lathe

50″ Sellers Wheel Lathe, Late

78″ Betts Vertical Boring Mill

10-16′ Betts Vertical Boring Mill

16′ Niles Vertical Boring Mill

12′ Niles Vertical Boring Mill

No. 4 LeBlond Boring Lathe

30″ x 48′ Niles Boring Lathe

14″ x 96″ No. 2 LeBlond Boring

No. 420 Barnes Deep Hole Drill

No. 3 B&S Universal Grinder

16″ x 36″ Norton Plain Grinder

10″ x 96″ Norton Plain Grinder

1H-6 Libby Turret Lathe, Chucking

3-R Gisholt, Long Bed

4-R Gisholt, 9¼″ Hole

Visit our booth — 433-434

1956

IRON AND STEEL EXPOSITION

Public Auditorium *Cleveland, Ohio*

September 25 - 28

SIMMONS
ENGINEERED
Rebuilding
GIVES MACHINE TOOLS A NEW LEASE ON LIFE

SINCE 1910 . . . *Builders and rebuilders of unconditionally guaranteed machine tools*

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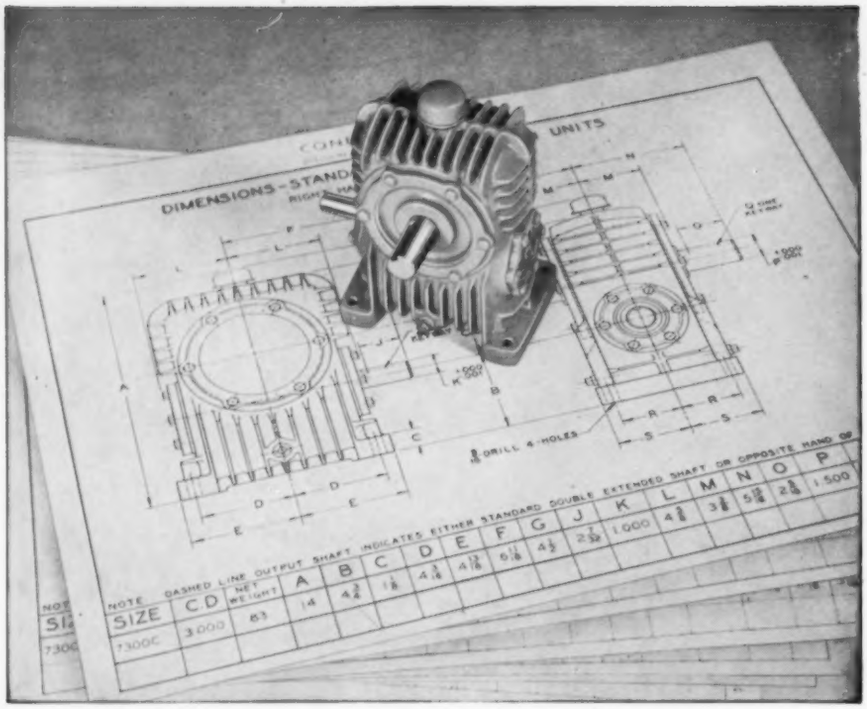


DIMENSIONS ONLY TELL HALF THE STORY...

. . . about worm gear speed reducers. You've got to compare size with load capacity for the whole picture. Inside a Cone-Drive speed reducer you'll find the double-enveloping worm gear design that makes it the most efficient right-angle speed reducer available.

Take the standard 3" center distance unit above for example. Here are its Class I Service Ratings with a 5:1 reduction:

Worm RPM	100	200	300	580	720	870	1150	1750
Mech. HP	1.24	2.21	3.08	4.89	5.61	6.34	7.41	9.04
Thermal HP	1.24	2.21	3.08	4.20	4.62	5.10	6.00	7.80
Output Torque (inch-lbs.)	3340	3010	2830	2405	2250	2150	1940	1575

That's a lot of capacity for a unit that occupies less floor space than this magazine page. But it's typical of Cone-Drive speed reducers and gearsets. Complete details on this model in Bulletin 600-C. Other units to 800 HP and ratios to 4900:1.

CONE-DRIVE GEARS
DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
Division, Michigan Tool Company
7171 E. McNichols Road • Detroit 12, Michigan

Kee Co., Cleveland, designers and builders of the Bellefonte furnace, is doing the relining. The job, estimated to cost just under $1,000,000, is expected to be completed in 60 days.

Armco's Sixth Street blast furnace at Ashland is also out of operation for a complete rebuilding and relining

WILL INSTALL FURNACE AT CF&I'S PALMER PLANT

▲ The Colorado Fuel & Iron Corp., Wickwire Spencer Steel Division, has awarded a contract to the Gas Machinery Co. to install a 40 ft long wire patenting furnace with a 20 ft long lead quench tank for their Palmer, Mass., Plant.

This furnace will be heated with Gas Machinery's patented silicon carbide radiant tubes, thus enabling higher thermal head and also permitting the use of a Protective Atmosphere.

AJAX BUILDS ADDITION TO WESTFIELD PLANT

▲ An addition to the plant of the Ajax Flexible Coupling Co., Inc. at Westfield, N. Y. is now under construction. This addition will be located on the company's 22-acre site and will practically double production.

The new addition is laid out on the one-floor plan for efficient, straight line production with latest materials handling equipment. New production machinery is scheduled to be delivered when the plant is ready for occupancy in early November.

VANADIUM-ALLOYS STEEL EXPANDS LATROBE PLANT

▲ An expansion program of its Latrobe, Pa. mill, which will approximately double the capacity of the entire plant has been announced by the Vanadium-Alloys Steel Co. This mill is exclusively devoted to the production of high speed steel.

Plans call for the extension of existing buildings adding 52,000 sq ft of space to the structures housing the rolling mills, hammer and melting shops. The expansion program will include the installation of new 10, 12 and 16 in. rolling mills plus all the necessary equipment for their operation. This will include roll turn-

ing equipment, cranes, shears, heating furnaces, annealing furnaces and the necessary material handling equipment.

All plans for the new expansion are completed and approved with actual construction expected to begin shortly after the contracts are let. It is expected the new facilities will be in operation in 15 months.

AWARD STRUCTURAL MILL CONTRACT TO BIRDSBORO

▲ Birdsboro Steel Foundry & Machine Co. has been awarded a multimillion dollar contract for the manufacture of structural steel mill equipment for U. S. Steel Corp.'s South Works.

Production on the contract has already started and delivery of all equipment involved is expected in from 12 to 17 months.

Many automatic features will be incorporated in the new equipment, including automatic transfer and turnover devices. The machinery will be used to roll all types of structural steel.

Birdsboro is designing, in conjunction with U. S. Steel engineers, and building all of the equipment provided for in the contract.

Principal elements in the contract are divided into three classifications: a structural mill hot bed and transfer equipment, structural mill straighteners and appurtenances, and structural mill cold saw, shears, gages and appurtenances.

USS STARTS PILOT LINE FOR VINYL COATED SHEET

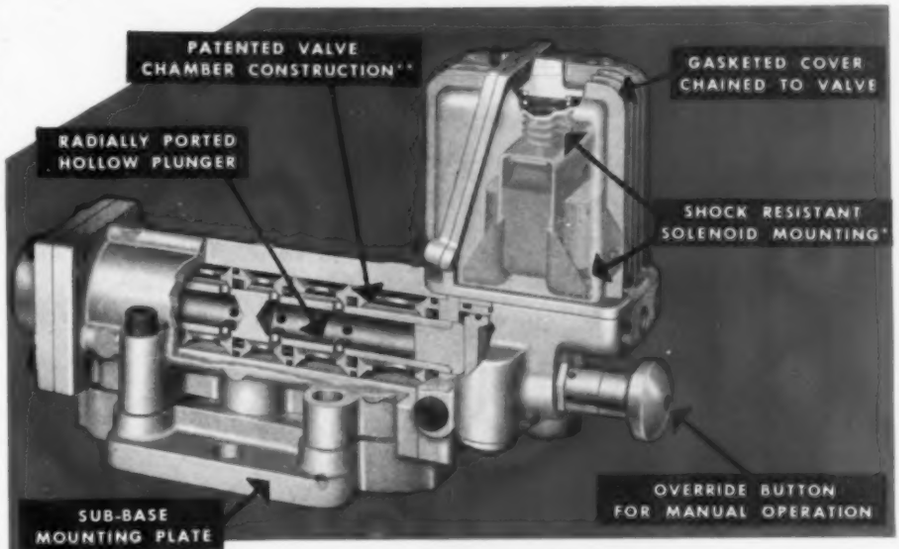
▲ A new product, combining the structural strength of steel with the rich decorative effects of vinyl plastic in an almost limitless variety of colors and textures, has graduated from the Research Laboratory and is now in experimental production at U. S. Steel's Irvin Works.

Cold-reduced sheets are coated with liquid plastic to produce an appealing, tough-surfaced sheet of great beauty and durability. It promises new decorative effects and long service in such equipment as refrigerators, radio and TV cabinets, wall panels, automotive bodies and trim, stove and

(Please turn to page 240)

Quick-As-Wink®

"B"-TYPE HIGH SPEED, HIGH CAPACITY SOLENOID VALVES


PATENTED VALVE CHAMBER CONSTRUCTION**
GASKETED COVER CHAINED TO VALVE
RADIALLY PORTED HOLLOW PLUNGER
SHOCK RESISTANT SOLENOID MOUNTING*
SUB-BASE MOUNTING PLATE
OVERRIDE BUTTON FOR MANUAL OPERATION

...offer many NEW advantages to make automation less costly and more dependable

Conservatively rated at 600 cycles per minute for continuous operation, these new, high speed valves feature:

1) **SHOCK RESISTANT SOLENOID MOUNTING*** available only in Quick-As-Wink design, reduces destructive hammering and vibration, assuring *greatly increased solenoid life.*
2) **VALVE CHAMBERS** formed by aluminum spacers held in accurate metal to metal end abutment** and sealed with "O" rings and "U" packers.
3) **HOLLOW, RADIALLY PORTED STAINLESS STEEL PLUNGER** directs the flow through the valve. No lapped joints.
4) **GASKETED DIE-CAST COVER** finned for cooling, held with captive screws and chained to valve.
5) **OVERRIDE BUTTON** permits manual operation in case of power failure.
6) **SUB-BASE MOUNTING** permits valves to be inspected — and serviced if necessary — without disconnecting *any* of the piping.

Available also in Double Solenoid, Lever Operated and Pilot Operated Designs.

Get full details about this outstanding new valve. Write for Bulletin No. 561—Today!

*Patent Applied For **U. S. Patent No. 2,645,450

Quick-As-Wink®
AIR AND HYDRAULIC
Control Valves

Hand, Foot, Cam, Pilot, Diaphragm and Solenoid Operated

Mfd. by C. B. HUNT & SON, INC., 1922 East Pershing St., Salem, Ohio

What's the best way

LINK-BELT conveying systems provide the answers to more production, less waste, improved safety and working conditions

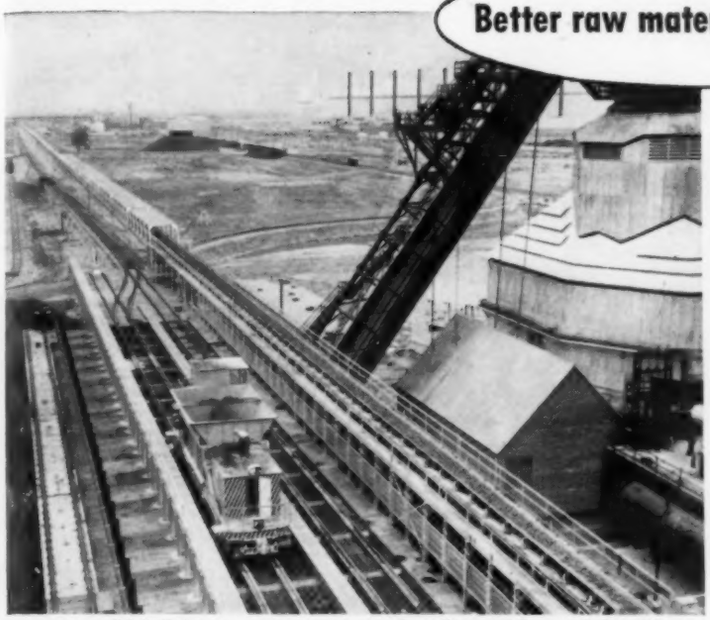
Overall efficiency involving every phase of steel production—from raw materials to finished product — is assured with Link-Belt's modern materials handling equipment. Link-Belt can supply complete conveying systems — designed to increase capacity, cut costs and reduce waste — for bulk materials, coils or any other form of steel.

Link-Belt's engineers will work with your engineers, consultants and builders of mill and process equipment to help you achieve these benefits in your mill. Just call or write your nearest Link-Belt district office.

This important Detroit steel mill greatly increased its cold rolled steel capacity — with no appreciable addition in floor space — by installing three Link-Belt conveyors. Much larger coils are now handled easily with less scrap loss and less idle mill time.

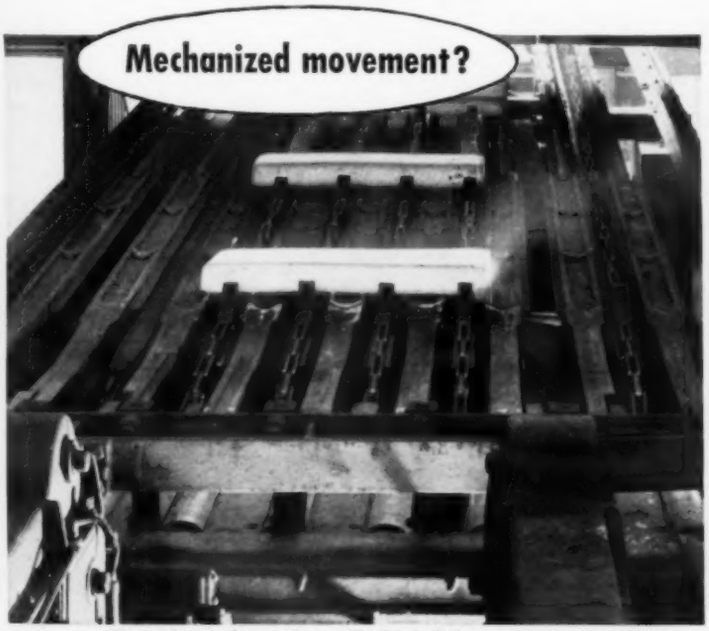
to boost your output?

Better raw materials handling?



Link-Belt conveyor systems solve the problems of handling and storing various ores, coke, stone, pellets and sinter which are required by the improved techniques of burdening blast furnaces. They are designed to utilize plant space more efficiently in existing mills — fit into the new processes and are suited to the higher capacities of ship unloading and increased production. Regardless of size or physical layout of your mill, Link-Belt can provide a system ideally suited to your conditions.

Mechanized movement?



Throughout the entire mill, Link-Belt conveyors contribute to higher efficiencies and capacities, better space utilization, lower costs and greater safety in the handling of slabs, billets, plates, coils and tubes, as well as raw materials. This conveyor employing Link-Belt steel chain transfers steel billets up incline.

Salvaging waste?

Mill scale recovery was boosted from 250 to 475 tons a week — 72% pure iron — after Link-Belt Straightline Collectors were installed at this mill. In addition, two previous problems (clogged sewers and river pollution) were eliminated. One of five recent L-B installations of this kind.

LINK-BELT

THE SYMBOL OF QUALITY — LB — LINK-BELT

MATERIALS HANDLING, PROCESSING & POWER TRANSMISSION MACHINERY

Don't miss the LINK-BELT exhibit at the Iron and Steel Exposition in Cleveland, September 25-28

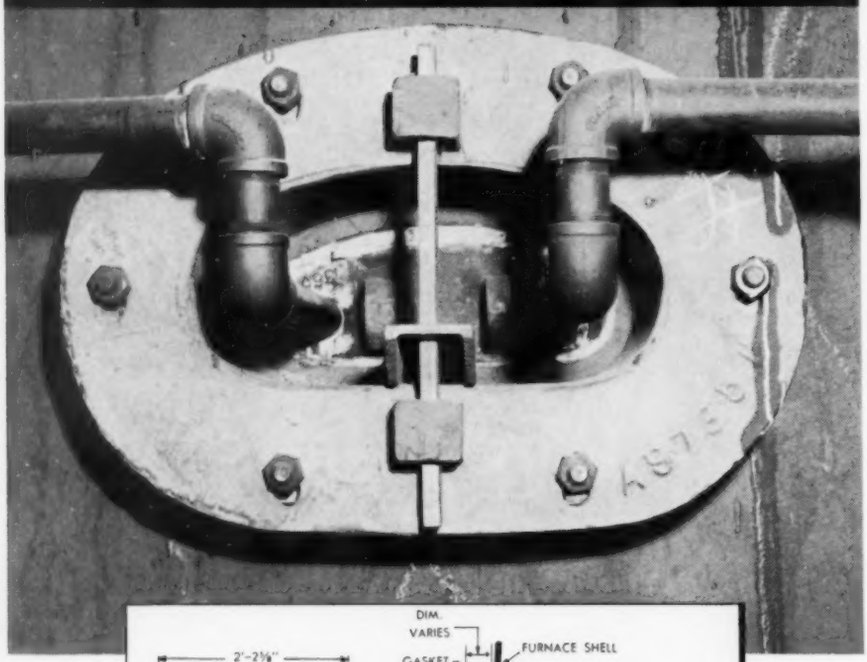
14,240

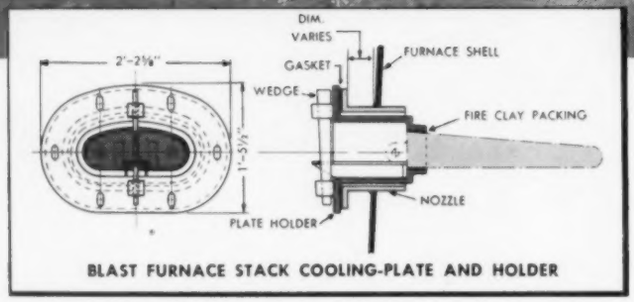
LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

New Bailey

BLAST FURNACE

COOLING-PLATE HOLDER





BLAST FURNACE STACK COOLING-PLATE AND HOLDER

- *Easy Removal*
- *Gas-Tight Seal*
- *For New and Relined Furnaces*

The unit is adjustable for maximum contact between brick and plates, and one size of holder can be used on all furnaces.

Write for Bulletin

WILLIAM M. Bailey COMPANY

ENGINEERS

LEADERSHIP THROUGH QUALITY

1221 BANKSVILLE ROAD PITTSBURGH 16, PA.

(*Continued from page 237*)

heater parts, railroad coach, club and sleeping car interiors, office and home furniture.

In the process of manufacturing, the steel is surface treated to improve its bonding qualities, a specially compounded adhesive is applied to the top surface and then cured by heating.

After air cooling, the steel enters a coating chamber where the thermo-responsive vinyl plastic is applied to the adhesive-coated surface. Again, heat is applied to solidify the plastic. Prior to cooling, the vinyl coating is embossed to obtain the desired design. or texture. The finished product is stacked by a magnetic piler.

The coating of this new material has excellent abrasion resistance and good electrical resistance properties. It is unaffected by humidity and many chemicals. The coating also produces sound-deadening effects similar to that obtained by "muffle coating" automobile bodies and will have value in acoustical design.

The new product, which can be supplied in any standard color, can be utilized for manufacturing many parts which heretofore required protective or decorative finishing after fabrication, such as, automotive panels, radio and television cabinets, institutional and office furniture, appliances, kitchens, wall panels, etc. Elimination of the need for such post-fabrication treatment, coupled with the unique properties of the new coated sheet, will result in lower production costs, together with superior wearing qualities and decorative effects.

At present, due to the developmental nature of the operation, no definite annual production capacities have been established. The pilot-line facilities at the Irvin Works will produce 18- to 28-gage sheets 24 to 52 in. wide. The semi-commercial product is being offered for sale on a developmental basis.

TO BUILD BLAST FURNACE FOR ITALIAN STEEL FIRM

▲ A contract for the design, procurement, and construction supervision of a blast furnace in Italy has been awarded to Koppers Co., Inc.

The blast furnace will be designed

(*Please turn to page 245*)

CLEVELAND NEWS, THURSDA

REMEMBER THE TIME—

Mack Sparkled Afield for Tribe

Ray Mack wore a magic glove while performing at second base for the Indians in the '40s.

Never a great hitter, Mack compensated for this with his brilliance afield. He possessed a cannon i place of a right arm and executed the doubleplay wi incomparable finesse.

Never was his talent so fully exploited than i Feller's opening day no-hitter against the Whit Chicago's Comiskey Park in 1940.

With two outs in the ninth and Feller one m immortality, Taft Wright, an outfielder the first base line. Mack raced the grou

You'll cheer, too, when you see the newest star in the materials handling big leagues . . . the Wellman Locomotive Crane. In its first few months of action, this power-packed performer has won fans by the hundreds among men who specify in steel plants, railroad terminals, scrap yards, paper mills. And no wonder! The new Wellman Locomotive Crane offers these outstanding features:

BALL RACE ROTATION... eliminating center pin construction, delivering smoothest operation.

TORQUE CONVERTER DRIVE... combining diesel electric power with hydraulic torque conversion.

POWER-POSITIONED A-FRAME... positive, simple adjustment of crane bail for heaviest loads on extra long booms.

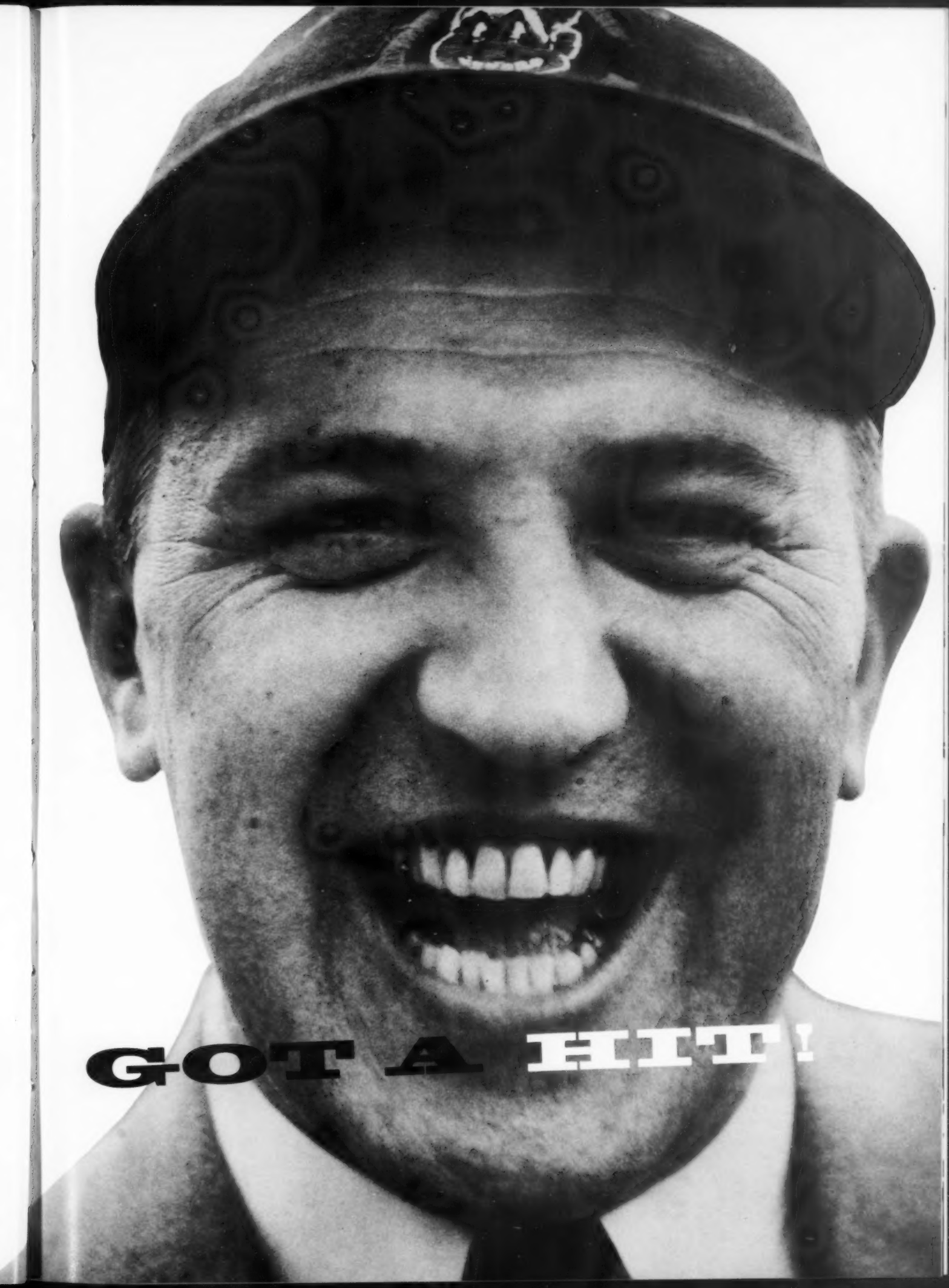
PLUS CAPACITIES FROM 25 TO 80 TONS... speeds to 15 miles an hour... extra-full-vision for operator... true air-powered brakes on hoist drums... push-button control for main disconnect clutch... all anti-friction bearings... many more exclusive features.

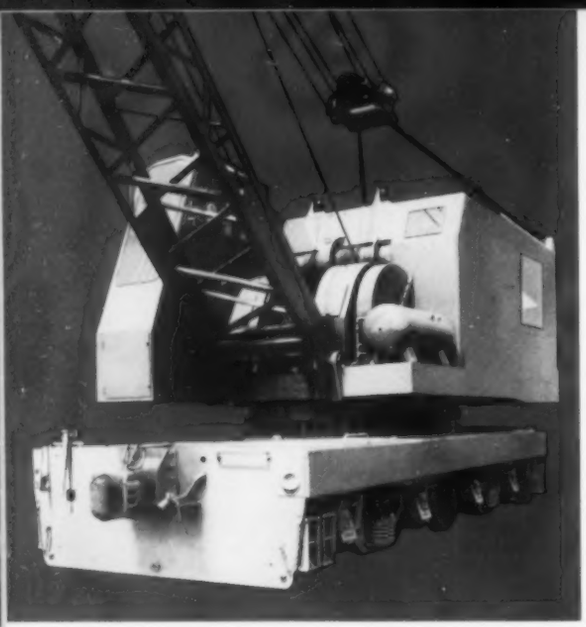
Ray Mack, former star second baseman for the Cleveland Indians, is a vice president of The Wellman Engineering Co. and general manager of its Locomotive Crane Division. His ten years in baseball began in 1938, the year he graduated from Case Institute of Technology in Cleveland as a mechanical engineer.

RAY MACK'S

Ray Mack will be at the Iron & Steel Exposition in Cleveland's Public Auditorium from September 25 through September 28. Look for the man with the biggest grin . . . and the finest locomotive crane ever built.*

**BOOTHS 216, 217, 218, 223, 224, 225*


GOT A HIT!



WELLMAN LOCOMOTIVE CRANES*

*SUCCESSORS TO BROWNING LOCOMOTIVE CRANES

Engineered and Built for Railroads . . . Steel Mills . . . Pulp and Paper Plants Scrap Yards . . . Terminals and Ports . . . Sand and Gravel Plants

The Wellman Engineering Co., now in its 60th year of service to basic industry, also produces complete heavy bulk materials handling plants and systems . . . steelmaking machinery . . . heavy hoisting equipment . . . the complete line of Williams contractors clamshell and dragline buckets and special industrial buckets . . . Anker-Holth air and hydraulic power cylinders in standard and special sizes and designs.

a McDowell enterprise

LOCOMOTIVE CRANE DIVISION
THE WELLMAN ENGINEERING COMPANY
7000 CENTRAL AVENUE · CLEVELAND 4, OHIO

THE McDOWELL FAMILY OF RELATED ENTERPRISES

McDowell Turnkey Plants • Dwight-Lloyd Research Laboratory • Wellman Bulk Materials Handling Systems and Steelmaking Machinery • Anker-Holth Power Cylinders • Dwight-Lloyd Ore Beneficiating Plants • ABCs Belt Conveyor Scales • Williams Buckets • Wellman Locomotive Cranes

---

Locomotive Crane Division
The Wellman Engineering Co.
7000 Central Ave., Cleveland 4, Ohio

Please send BULLETIN WL-201 describing the new Wellman Locomotive Cranes in detail.

NAME ..... TITLE .....

COMPANY .....

STREET .....

CITY ..... ZONE ..... STATE .....

Litho in U.S.A.

(*Continued from page 240*)

for ILVA, Alti Forni E Acciaieri D'Italia of Genoa, Italy. ILVA is a subsidiary of "Finsider," a financial group operating a number of steel companies representing about 60 per cent of the steel production of Italy. The new blast furnace will be constructed by the firm at its Bagnoli Plant near Naples.

When the blast furnace, which will have a hearth diameter of 26 ft six in., is completed, it is estimated that it will produce approximately 1,200 metric tons of molten iron per day. equivalent to 1,320 U. S. net tons a day. Design of the blast furnace is well under way and construction completion is estimated for sometime next year.

The new blast furnace will be the forth at the Bagnoli Plant site and its construction will be the first step in an expansion program ILVA has planned to triple iron production. The other three furnaces are very small and each produces approximately 400 metric tons of iron per day. ILVA expects to replace these furnaces with two additional blast furnaces the size of the one now under construction.

UNITED RECEIVES ORDER FOR SLABBING MILL

▲ The Steel Co. of Canada, Ltd., has placed an order for a 46 in. x 100 in. 2 high slabbing mill with the United Engineering and Foundry Co.

The order includes the necessary auxiliary equipment for handling the ingots through to the piling of the completed slabs. The mill is powered by two 5000 hp electric motors; handles ingots up to 60,000 lb in weight, and produces slabs up to 72 in. in width. It has an estimated capacity of 2,800,000 tons of slabs per year.

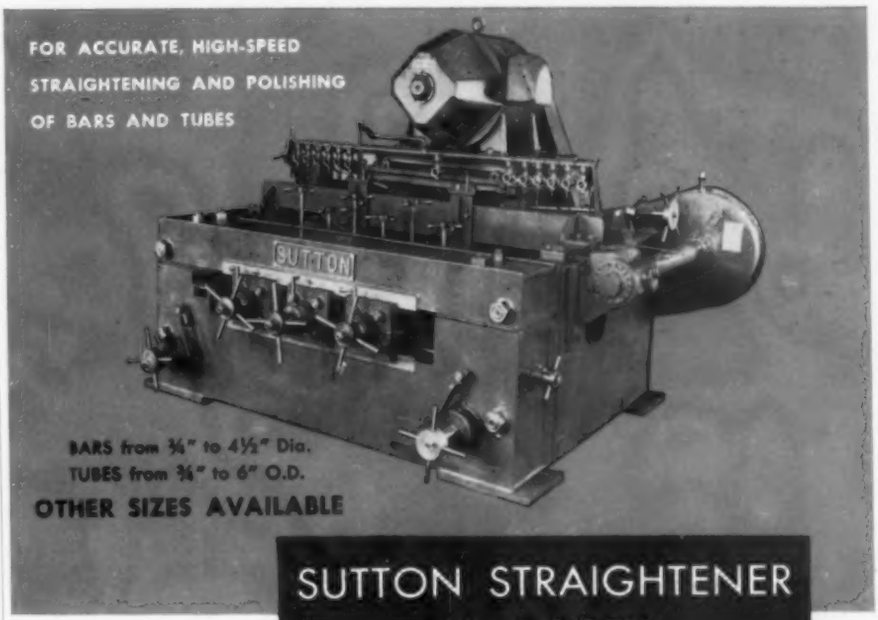
It is expected that delivery will be made in the spring of 1957.

KAISER PLACES ORDER WITH WESTINGHOUSE

▲ Kaiser Aluminum & Chemical Corp. has ordered rectifier equipment valued at $4,000,000 from Westinghouse Electric Corp. to provide direct current electricity for two aluminum potlines at its Ravenswood, W. Va., reduction plant.

SUTTON STRAIGHTENING

LEADS THE FIELD!



SUTTON STRAIGHTENER
Model 2FX

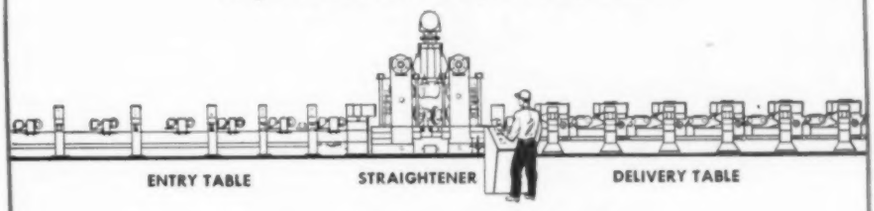
For **TUBES PIPE BARS** *and* **SHAPES** *of all* **MODERN METALS**

Today, as in the past, leading mills specify Sutton for the finest straightening available.

Standard or special model straighteners can be furnished for almost every application. Quality of end product, high speed production and dependability of operation are assured by our forty years of straightening experience.

SUTTON ENGINEERED STRAIGHTENING

May Be Installed Directly In The Mill Line



Proposals furnished at no obligation

Ask for Bulletin No. 25

SUTTON *Engineering* COMPANY

Manufacturers for Ferrous and Non-Ferrous Metal Industries

STRAIGHTENERS, EXTRUSION PRESSES, HYDRAULIC STRETCHERS, SHEET LEVELERS, CONTOUR CORRECTING MACHINES, STRAIGHTENING PRESSES, ROTARY CLEANERS, HEAVY-DUTY UNIVERSAL JOINTS, ROLLS

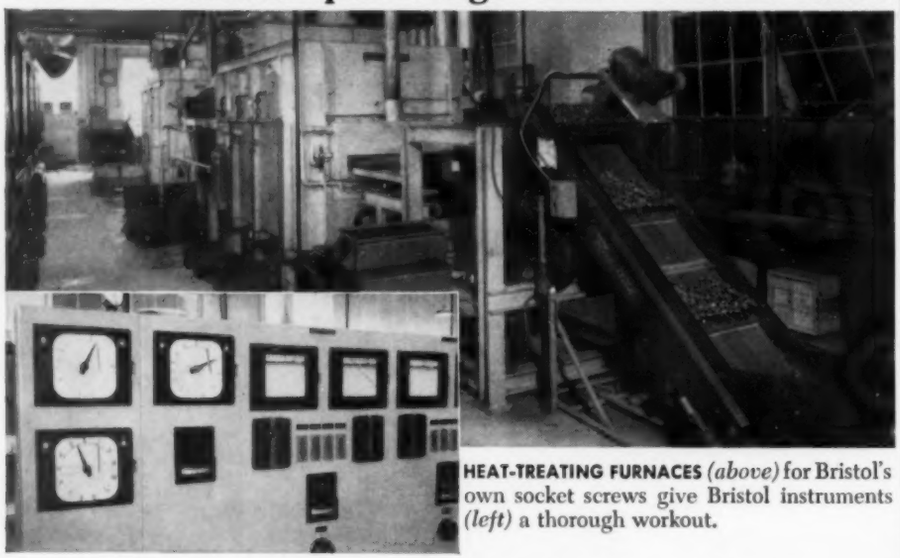
FIRST NATIONAL BANK BLDG., PITTSBURGH 22, PENNSYLVANIA
PHONE: GRANT 1-8077 **PLANT: BELLEFONTE, PA.**

BRISTOL'S

Instrumentation News

• *News of instrumentation and automatic control in industrial heating and metallurgy* •

New instruments pass tough "field" tests at home



HEAT-TREATING FURNACES *(above)* for Bristol's own socket screws give Bristol instruments *(left)* a thorough workout.

New Bristol instruments for metal-treating operations have a ready-made proving ground in Bristol's own socket screw manufacturing division.

Bristol instruments monitor and automatically control every phase of the Socket Screw Division's metal treatment—including a variety of continuous and batch-type furnaces, salt-baths, and tinning and degreasing operations for specialty products.

Completely automatic control assures highest quality and uniformity for Bristol socket screw products. New instruments get grueling "field" tests before they're released for general distribution. And, last but not least, visitors to the Waterbury plant can see Bristol instruments under actual load conditions.

Drop in, when you're in the New England area, and watch these precision instruments at work!

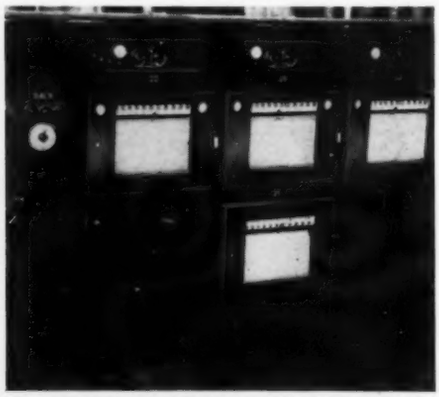
New control techniques cut fuel bills for metals

In 20 years, fuel required for ingot heating has dropped 50 to 60%.

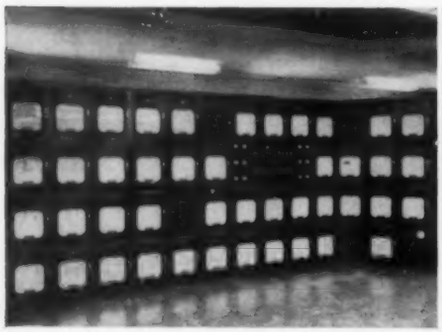
A big share of the credit for this fuel economy goes to automatic control and instrumentation techniques developed recently. These new techniques, with better, faster, more accurate sensing and response, have chalked up significant savings, not only in fuel, but also in fixed charges, rolling time, and maintenance costs.

Probably most important for big savings is control of furnace temperature and atmosphere. Furnace pressure may be regulated by positioning the stack damper. Fuel-air ratio can be controlled by a valve in the air line. Air requirements for combined fuels may be totalized for better distribution of fuel throughout the plant.

Proper temperature-time sequences or "time cycles" also rack up big savings. Step heating sequences, differing for various metal ingots, no longer need be programmed by rule of thumb. Instead, any predetermined sequence of temperatures can be maintained automatically and easily changed to suit particular batches.



THESE BRISTOL ELECTRONIC AND AIR-OPERATED pyrometers automatically control regenerative soaking pits. Platinum, platinum-rhodium thermocouples at pit covers are sensing elements.



Telemetering helps control steel plant fuel

This Bristol telemetering installation helps U. S. Steel, Gary, Indiana, get the highest steel production with the lowest possible fuel cost.

The panel shows the amount of coke-oven and blast-furnace gas used throughout the plant as well as gas pressures at critical locations. With this complete supply and demand information at their fingertips, fuel dispatchers can control distribution for maximum efficiency and economy.

Precision rolling mill produces steel tapes 0.000125" thick

This precision cold-strip mill at The Arnold Engineering Company, Marengo, Illinois, rolls ultra-thin high-permeability strips for magnetic cores. The core strips may be as thin as 0.000125" and must be held to extremely close tolerances. To achieve the necessary precision, AccuRay gauges—employing Bristol Dynamaster recorders—measure thickness of material on both sides of the rolling mill. The AccuRay equipment is built by Industrial Nucleonics, Columbus, Ohio.

Want to apply these up-to-date control and instrumentation techniques to your industrial heating problem? Bristol engineers will be glad to talk over specific processes, problems, facts and figures with you. Write today to The Bristol Company, 123 Bristol Road, Waterbury, Conn.

BRISTOL *POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION*

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

Westinghouse plants in Sharon, Pa., East Pittsburgh, Pa., and Newark, N. J., will supply the equipment which includes rectifier transformers and metal-enclosed pumped-rectifier assemblies complete with switching and control equipment.

It also includes power circuit breakers, outdoor switching structure, regulating phase-shift and rectifier transformers, anode circuit breakers, cathode circuit breakers, duplex control board and ignitron assemblies.

This is one of the first installations in aluminum production service where conventional pumped ignitron tubes are furnished in metal enclosures and close-coupled to anode and cathode switchgear.

COLD MILL CONTRACT AWARDED TO MESTA

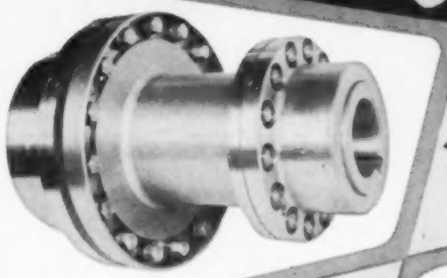
▲ The Mesta Machine Co. has been awarded a contract covering the design and manufacture of a 48 in. five-stand tandem four-high cold mill. The installation will be made at the Sparrows Point, Md., plant of the Bethlehem Steel Co. and will be designed for cold reducing hot rolled and pickled steel strip to a maximum width of 44 in. Thicknesses will range from .065 in. to .125 in. for reduction to tin plate gages. This mill will be geared for a maximum speed of 6000 fpm with an average operating speed of about 4800 fpm, depending on the type of product being rolled. The total hp driving this mill will be 21,150. The equipment will include an entry conveyor, 60 ft long; a delivery conveyor 20 ft long; and coil handling equipment suitable for coils approximately 73 in. diameter and weighing approximately 1000 lb per inch of width.

Mesta will be responsible for the complete layout; will make all the engineering details required for the construction of foundations and electrical systems and will supervise the work of installation in the field.

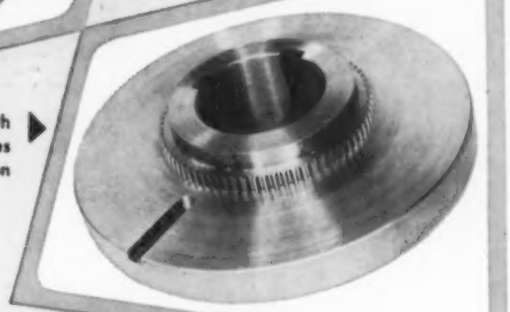
Meetings

▲ The 14th annual Electric Furnace Steel Conference, sponsored by the Electric Furnace Steel Committee of the American Institute of Mining, Metallurgical, and Petroleum Engineers will be held Dec. 5-7, 1956, in the Morrison Hotel, Chicago, Ill.

Does your problem call for a Specially Built Coupling?



Specially designed Coupling for use in a wind tunnel



WALDRON Coupling hub with special plate provides required sliding motion

then put your problem up to

Waldron

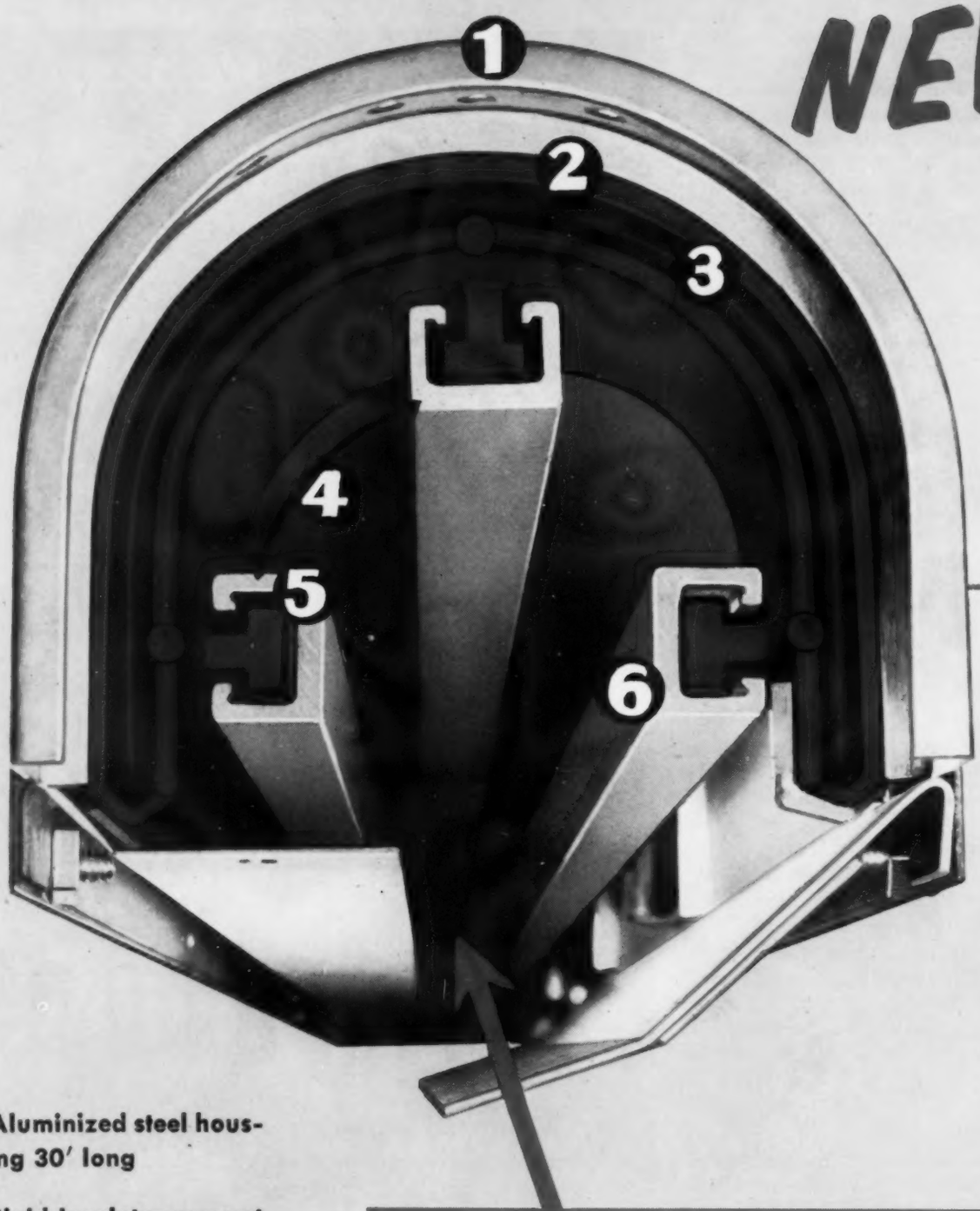
The extensive engineering and manufacturing facilities maintained for the production of our popular standard type couplings put WALDRON in the most favorable position for handling special orders. WALDRON is the recognized source for prompt service on unusual coupling applications.

JOHN WALDRON CORP. • NEW BRUNSWICK, N. J.

Sales representative in Principal Cities

STANDARD TYPES — Waldron COUPLINGS — SPECIAL TYPES

NEW



1. Aluminized steel housing 30′ long
2. Rigid insulator support
3. Rugged petticoat insulator
4. Maximum leakage distances
5. Trolley rolls on aluminum bus bars
6. Current pick-up surface for rugged trolley

"SAFETY-SLOT" COVER FOR MAXIMUM SAFETY

Elbowed trolley arm passes freely along slotted bottom cover but accidental contact with current-carrying members of system is practically impossible. A positive guard for personnel.

HKP

Electric Service Works, DELTA-STAR ELECTRIC

17th AND CAMBRIA STREETS

KEYSTONE

LEC-TROL-FEED*

HEAVY-DUTY LIGHTWEIGHT TROLLEY BUSWAY SYSTEM

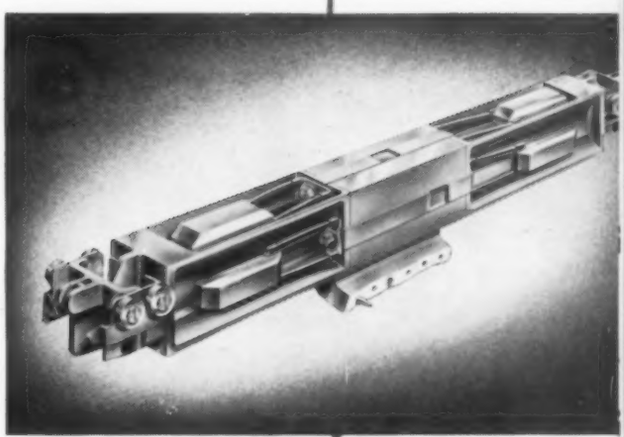
Fast-action INSTALLATION...

Safety-first POWER

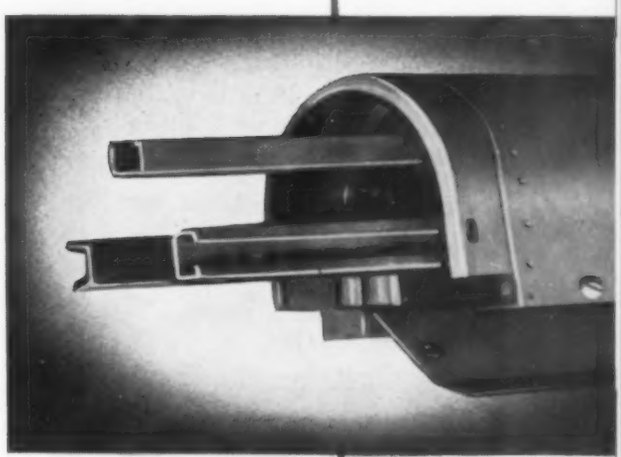
THE NEW LIGHTWEIGHT SYSTEM FOR CRANES, HOISTS, STRAIGHT-RUNWAY EQUIPMENT

SAFE POWER is the cheapest power. The new Keystone LEC-TROL-FEED System wipes out hazards of open systems . . . brings new dependability to tough installations . . . works long and hard without needing attention.

And the system starts paying its board and keep right away. Because of its preassembled units, its lightweight aluminum bus bars, its longer track sections and simple design, it saves you on installation. Write today for complete data.



RUGGED TROLLEY ASSEMBLY built to take heavy continuous operation. Insulated wheels guide trolley along bus bars, special alloy sliding shoes collect current from bus bars.



PREASSEMBLED UNITS cut installation time, carefully engineered components make servicing and alterations fast, easy, safe.

SAFETY-FIRST with fully enclosed steel housing. Maximum protection against contact with current-carrying bus bars from any direction. Built-in safety lets you locate system where most convenient—indoors or outdoors.

RUGGED to take rough treatment, heavy continuous duty. Corrosion-resistant aluminized steel housing, high-strength aluminum alloy bus bars, petticoat-type insulators, sturdy trolley with massive components for extra severe operating conditions. Most efficient A.C. or D.C. service, greatest phase-to-phase leakage distance with delta conductor arrangement.

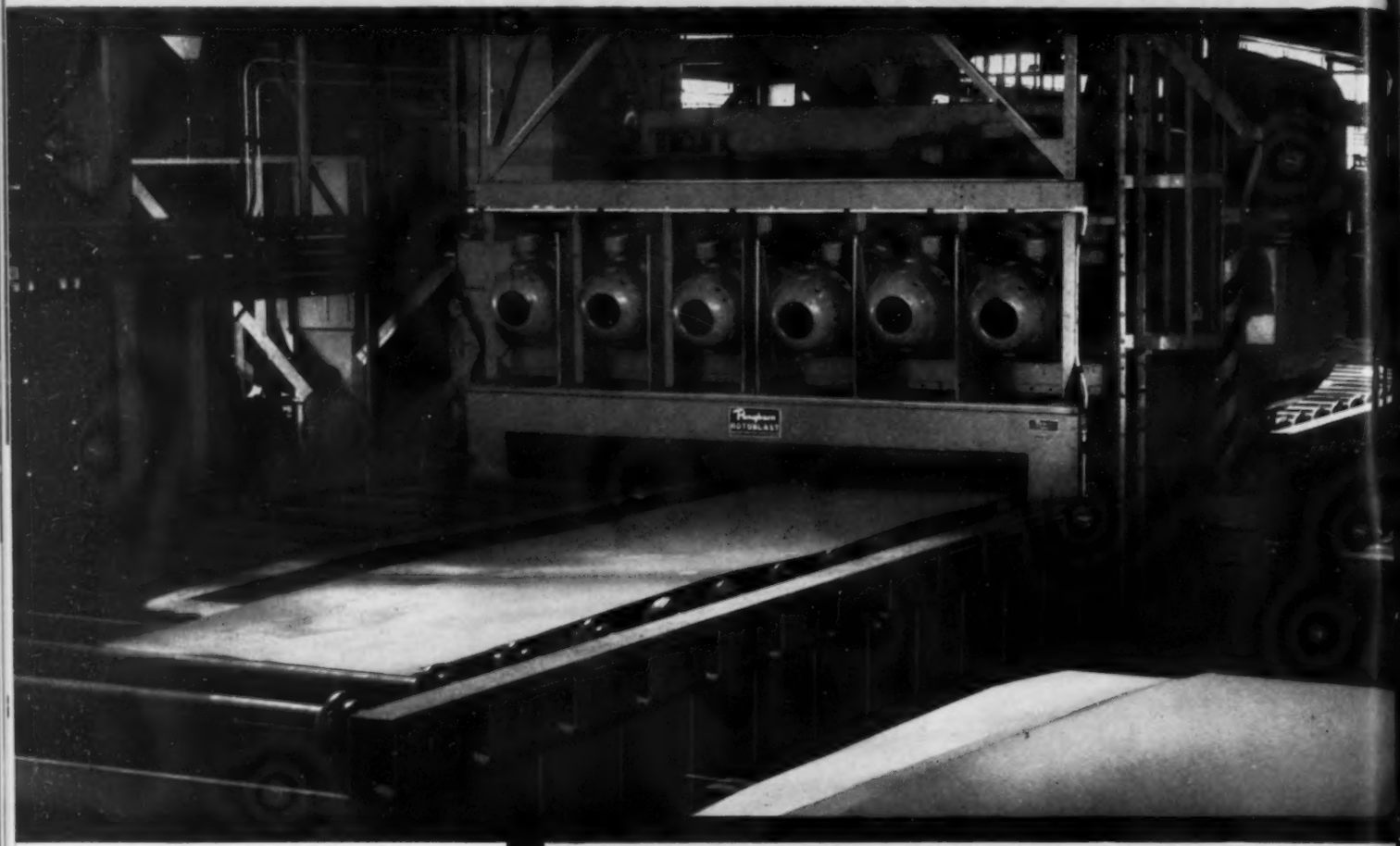
FAST, EASY to install and service. Prefab units cut installation time considerably; longer track sections mean fewer joints, rigidity of track requires fewer hangers. Removable safety covers make every part easily accessible. System can be relocated, expanded or altered with a minimum of effort.

*Trade Mark

See it in Booth 463 at the Iron and Steel Show

DIVISION, H. K. PORTER COMPANY, INC.
PHILADELPHIA 32, PA.

Descale steel sheets, plates, coils



No more scale breaking or pickling! No more acid disposal problems! Pangborn Rotoblast Descaling Machines descale steel sheets, plates and coils, and they operate at big savings over pickling costs!

How? They work quickly. They clean thoroughly. They're a one-man operation. Unlike acid baths, they can be located near your production, cutting handling costs. And they save floor space, require much less room than vats. Available in a variety of models, Pangborn Rotoblast Descaling Machines handle steel sheets, plates and coils of any thickness, width and length. If you want to cut descaling costs to the bone, investigate Pangborn Descaling Machines!

For complete information, send for Bulletin 608. Write: PANGBORN CORPORATION, 4400 Pangborn Blvd., Hagerstown, Maryland.

Visit our Booth 8 to 12, Iron and Steel Exposition, Cleveland, September 25 to 28

at *less than half the cost*

*U. S. Pat. # 2184926 (other patents pending)

with Pangborn Rotoblast® Descaling Machines!

Pangborn

3 BS

BLAST CLEANS CHEAPER

Rotoblast Blastmaster® & Continuous-Flo Barrel

Rotoblast Tables & Table-Rooms

Special Blast Rooms & Cabinets

Pangborn Dust Control Equipment

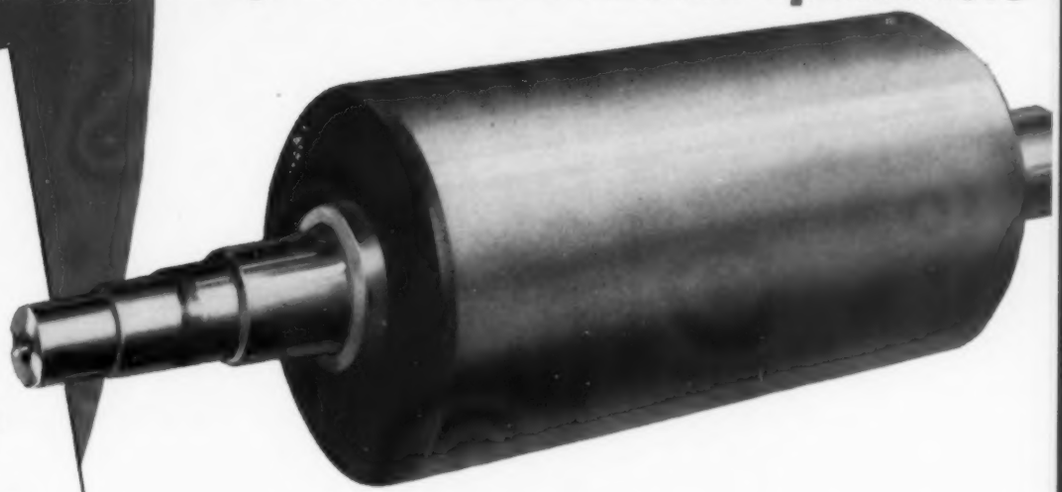
Malleabrasive* Shot & Grit

Get the *right* answers to your Roll problems from "YOUNGSTOWN"

hot and cold strip mill maintenance specialists

Q. How can scratching, galling, pickup, and excess wear be eliminated?

A. Use PARALLOY... the Rolls of uniform hardness all through. Roll more tonnage from new to scrap diameter.



PARALLOY

HOT STRIP COILER ROLLS • COILER PINCH ROLLS
PICKLING LINE PINCH ROLLS • UPCOILER ROLLS
CLEANING LINE PINCH ROLLS • SINKER ROLLS
CARRIER ROLLS • TEMPER MILL TENSION ROLLS

Q. How can heat check, warpage and cracking be overcome?

A. Let Youngstown's proven experience with Ductile Cast Iron help you in the applications at right.

DUCTILE IRON

RUNOUT TABLE ROLLS • HOLDING TABLE ROLLS
LOOPER TABLE ROLLS
LOOPER TABLES • APRON PLATES

Ductile Cast Iron Rolls are reducing maintenance in hot strip mills . . . especially good under the sprays. We invite your inquiries on rolls or any other ductile iron castings up to 50,000 pounds.

The Youngstown Foundry & Machine Co.
SERVING INDUSTRY SINCE 1885
Youngstown, Ohio

You can pull these plugs at full load . . . SAFELY!

Circuit-Breaking Arktite

PLUGS AND RECEPTACLES

20 amp. to 400 amp.—250V D.C.; 600V A.C.

SAFE at all times—even if you pull an *Arktite* plug to disconnect an energized motor or appliance in an emergency!

You don't have to open the disconnect switch before withdrawing an *Arktite*. Arcs created as line and load poles disengage are confined in deep, insulated arcing chambers—are instantly snuffed out by pressure-deionization and lack of oxygen. There's no possible danger of flashover injuring personnel or destroying property.

Contact your Crouse-Hinds Distributor, nearest Crouse-Hinds Office or Representative for complete information.

NEW, Re-Designed *Arktites*...

Feature new pressure connectors — new easier-to-wire 1-piece interior assemblies — new easier-to-interchange plug and receptacle interiors — new plug adaptability to any type and size cable.

Fully interchangeable with older style. Same price. Currently available in 30 and 60 amp. sizes, in 2-, 3- and 4-poles.

● **Operated like a giant switchboard, this *Arktite* installation with variations in power, frequencies and voltages is used to speed up machine tool testing. Plugs can be inserted and withdrawn from "live" receptacles without using a disconnect switch.**

A NATIONWIDE DISTRIBUTION exclusively through ELECTRICAL DISTRIBUTORS

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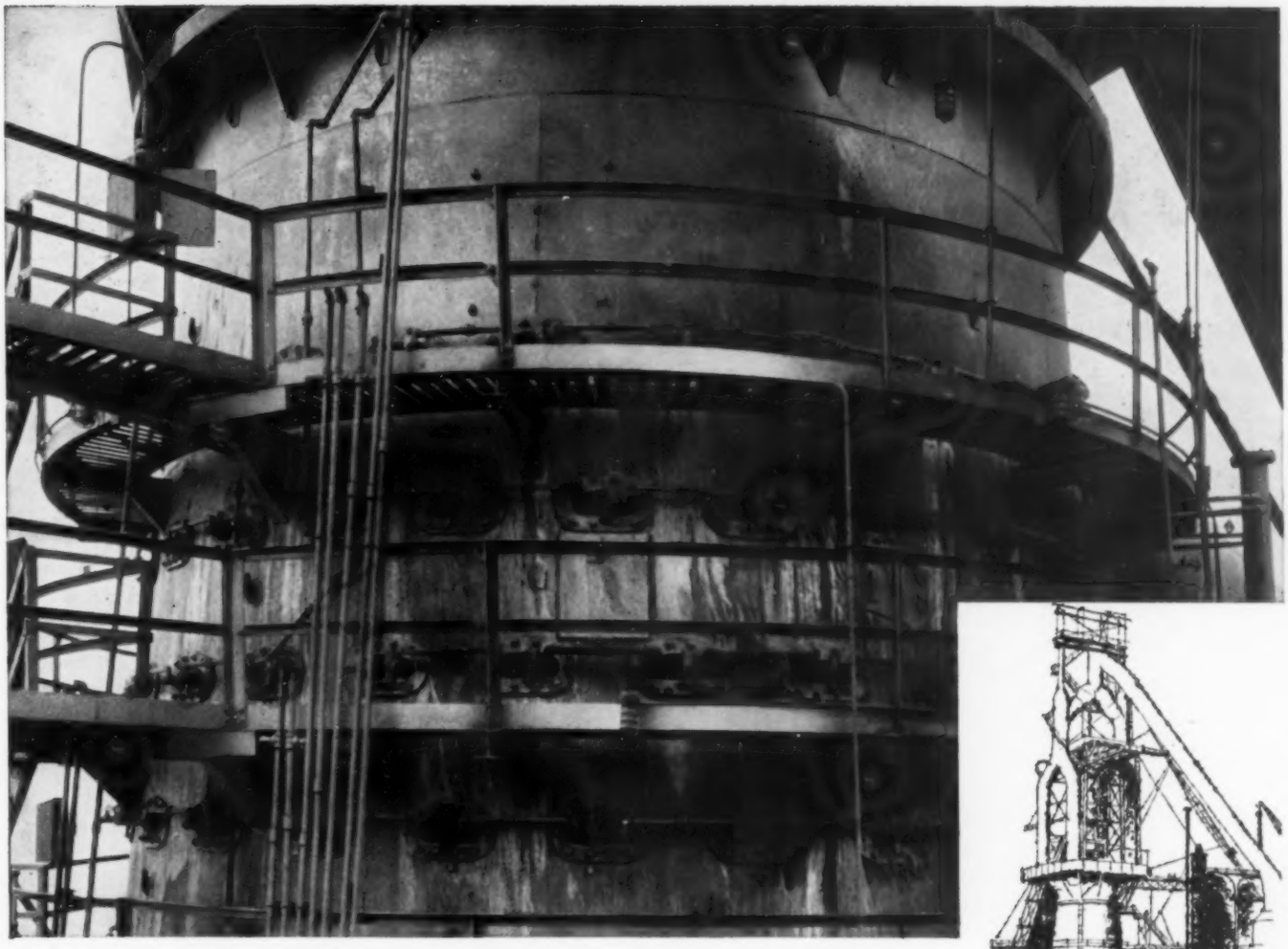
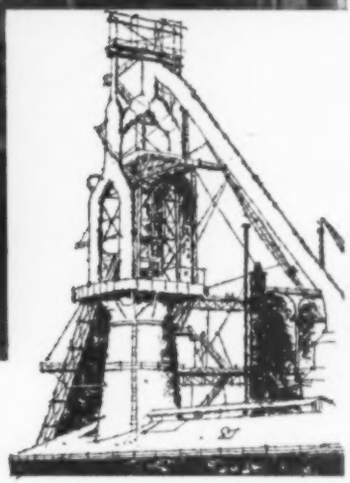
CONDULETS • FLOODLIGHTS • TRAFFIC SIGNALS • AIRPORT LIGHTING





Why Airco 78E electrodes were selected to weld blast furnace "R"

A large eastern steel producer planned to build the giant blast furnace designated "R". Welding – with its obvious advantages of speed and economy – was naturally selected as the best method of construction.

But – which electrode would best do the job? These were the factors involved in making a decision:

(1) Quality of weld deposit. Welds had to be leakproof to contain the 15 lb. psi pressure in the vessel. **(2)** High ductility and tensile strength were of prime consideration. **(3)** An all-position electrode was absolutely essential.

The Airco 78E electrode answered all these qualifications. Therefore, it was the logical choice. A total of 13,500 pounds of Airco 78E electrodes were used to weld the structure.

In building a blast furnace – or rebuilding an engine housing – Airco's Electrode Pocket Guide can help you take the guess work out of selecting the right electrode for the job. This 44-page booklet contains neatly condensed descriptions, applications and procedures – plus charts and graphs – for using the complete Airco line of electrodes.

It's free. Write Airco, at the address below. Request Catalog 1318.

AT THE FRONTIERS OF welding PROGRESS YOU'LL FIND . . .

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Offices and dealers in most principal cities

AIR REDUCTION SALES COMPANY

A division of Air Reduction Company, Incorporated, New York 17, N. Y.

On the west coast –
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In Cuba –
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In Canada –
Air Reduction Canada Limited

Products of the divisions of Air Reduction Company, Incorporated, include: **AIRCO** – industrial gases, welding and cutting equipment, and acetylenic chemicals • **PURECO** – carbon dioxide, liquid-solid ("DRY-ICE") • **OHIO** – medical gases and hospital equipment • **NATIONAL CARBIDE** – pipeline acetylene and calcium carbide • **COLTON** – polyvinyl acetates, alcohols, and other synthetic resins.

8 good reasons why you should use these ROLLER GUIDES in your bar or wire rod mill

Nos. 125 and 155 roller guides fitted in a 27 1/2 in. (700 mm.) diameter, three-high stand for rolling 2 3/4, 3 3/16, 3 9/16, 4, 4 3/8 and 4 7/8 in. (70, 80, 90, 100, 110 and 124 mm.).

1 The entry friction guides are rigidly clamped into the guide box. They are intended to lead the oval to the groove in the roller, to protect the rollers against overloading, and to straighten bent rods.
The groove in the entry guides is made about 1/8" wider than the oval.

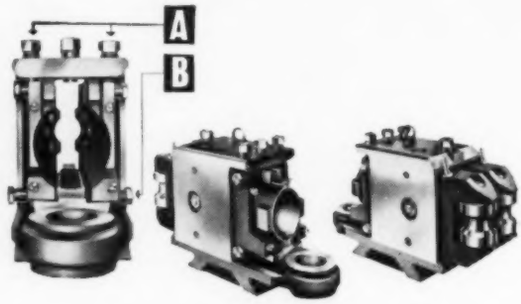
2 The rollers are mounted on leaf springs, which can be adjusted by means of the screws "B", and hold the oval steadily even if there should be some slight variation in the thickness of the oval.

3 If the thickness of the oval should vary, the springs of both rollers yield an equal amount, so that the oval remains in the centre of the groove.

4 To tilt the oval, the screws "A" are adjusted. One roller will then be lifted as much as the other is lowered.

5 As the oval is held very rigidly, the leader oval for wire rod may be thick, unless other circumstances call for a thinner oval.

6 The roller guide assemblies are narrow, and all screws that require adjustment during rolling are accessible from the front of the mill. No lateral space outside the guide box is therefore required for gaining access to the set screws, and the guide box assembly can thus be located close to the mill housing.



7 As the groove in the entry guides is wide and nothing but rolling friction acts on the oval, the latter is very easily introduced into the pass, and there is practically no risk of scratching the bar.

8 The roller guide may be used not only for leader and drawing oval passes but also for edging flats as well as for rolling squares, hexagons, octagons and various other sections, for instance in reduction passes for hexagon. It is suitable for all types of rolling mill. An important advantage is that the roller guide enables repeaters to be used in rolling plump leader-ovals.

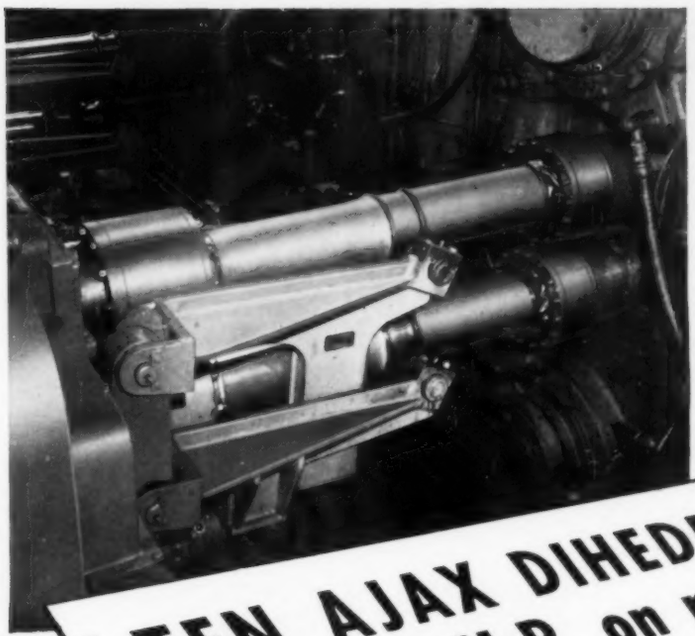
PS *Practically speaking, every bar and wire rod mill in Scandinavia uses roller guides of our design.*

MORGÅRDSHAMMAR

MORGÅRDSHAMMARS MEK VERKSTADS AB • MORGÅRDSHAMMAR • SWEDEN

SOLE AGENT FOR THE US:
K.W. Atwater Engineering, Inc.
401-03 Butler Street
Pittsburgh 23, P.A.

Telegrams: Morgårdshammar, Ludvika. Sweden



TEN AJAX DIHEDRAL COUPLINGS deliver 25,000 H.P. on new U E & F mill at Weirton

Close-up shows two of five pairs of Ajax Dihedral Spindle Couplings driving 23" and 56" x 52" 4 high 5 stand tandem cold mill built by United Engineering & Foundry Co. for Weirton Steel Co., a Division of National Steel Corporation.

▶ The critical eyes of steel men are focused on the design, performance and output of every new mill and all its components. This new 4 high, 5 stand tandem cold mill, designed for speeds up to 7200 fpm, was built by United Engineering and Foundry Co. for the Weirton Steel Co., a Division of National Steel Corporation.

It is turning out sheet of high quality finish and maintaining close gauge tolerance.

Power is transmitted from drive stands to rolls by 10 Ajax Dihedral Spindle Couplings handling 2500 H. P. each. The uniform angular velocity of Ajax Dihedral Spindle Couplings is an important factor in producing smooth finish, uniform thickness and long roll life.

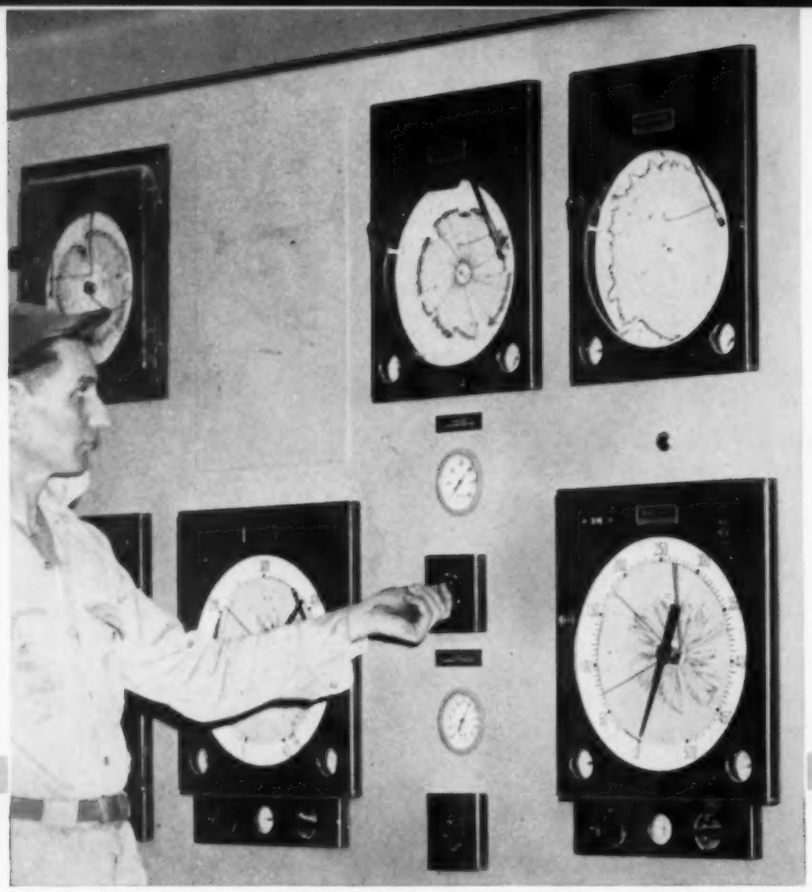
Ajax Dihedral Spindle Couplings are in operation in America's foremost steel mills. They have been proved and approved by every test of time and service. Whether you are designing, specifying, building, using or modernizing mills, it will pay you to get the facts on Ajax Dihedral Spindle Couplings.

Write for Bulletin No. 58.

AJAX®

Get first hand information at the Ajax Exhibit during the Iron and Steel Show, Booth Nos. 101-2-3.

AJAX FLEXIBLE COUPLING CO. INC.
WESTFIELD, N. Y.

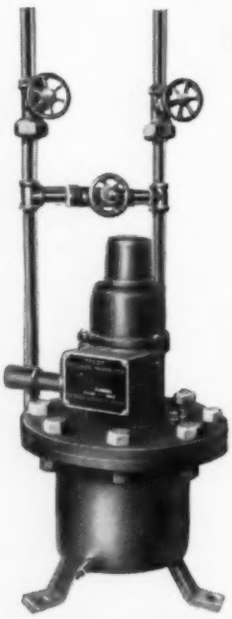


Honeywell

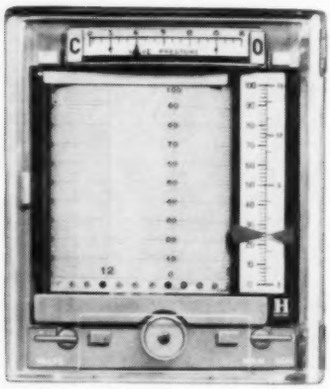
At the turn of a dial, the furnace operator can set the required total Btu input for a multiple-fuel open hearth furnace. The Honeywell Fuel-Air Ratio control system automatically uses as much byproduct coke oven gas as is available, adds oil as needed for the total Btu input, and adjusts both fuel and air in correct proportion.

Instrumentation for every furnace . . . every fuel

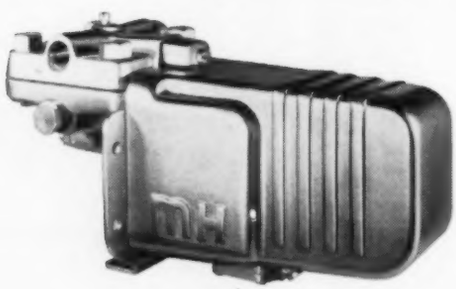
Flow of viscous fluids such as Bunker C oil, tar and pitch is measured by this Area Meter. Linear electrical signal is transmitted for remote indicating, recording, controlling or totalizing.



Air or gas flow is metered by this bell type meter body, which transmits electrically to remote instruments on the control panel.



For graphic or centralized control, *Tel-O-Set* miniature indicators, recorders and controllers save panel space . . . provide accurate, flexible instrumentation for temperatures, flows, pressures.



Differential Converter mercuryless pneumatic transmitter can be used for steam, air or gas flow measurement. Rugged and sensitive, it is easily calibrated in the field.

Metered Fuel-Air Ratio Control *saves fuel dollars*

Fully automatic systems cut costs on single, alternate, or combined fuel-fired installations

HONEYWELL metered fuel-air ratio control systems on your furnaces will get the maximum Btu's from available fuel. Moreover, in addition to saving fuel dollars, these systems are designed for operating convenience.

For example, an operator can check firing conditions by merely glancing at the large, easily-read charts and scales on the *ElectroniK* controllers. With the turn of a knob, he can set up automatic Btu input control, or switch over to manual control for startup or emergency operation.

Honeywell metered fuel-air ratio control systems are, fundamentally, fuel savers, and are applicable to gas, oil, tar, pitch, air, or steam flow measurement and control. They provide direct and immediate indication of set points and ratio settings. Where panel space is limited or where graphic centralized panel operation is desirable, Honeywell miniature *Tel-O-Set* instruments can be supplied in these systems.

Each system is individually engineered to your specific furnace and fuel requirements. For a discussion of what Honeywell metered fuel-air ratio systems can do for you, call your local Honeywell sales engineer . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

● **REFERENCE DATA:** Write for Data Sheets No. 4.3-4a, "Fuel-Air Ratio Control Systems"—and No. 6.4-12, "*ElectroniK* Inductance Bridge Receivers."

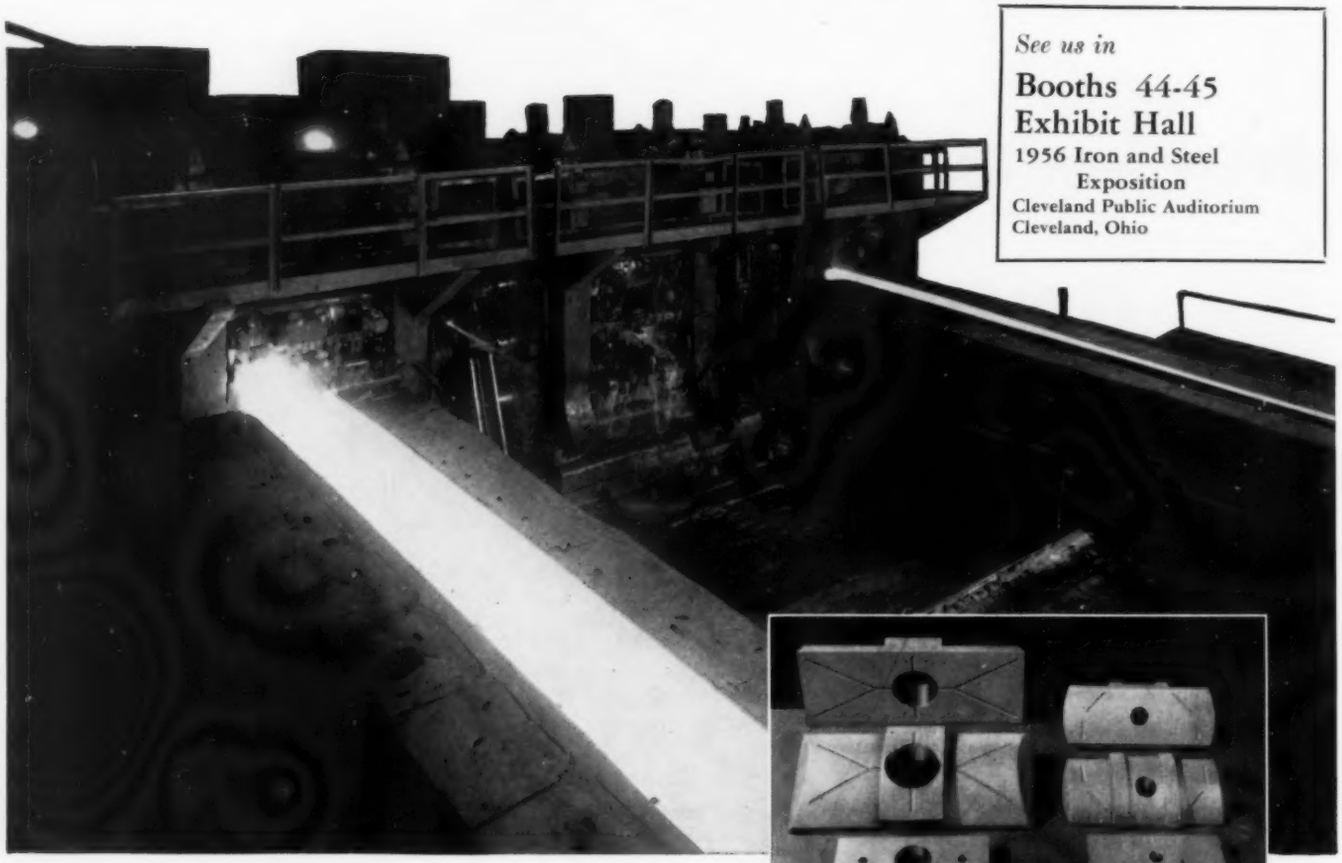
MINNEAPOLIS **Honeywell**

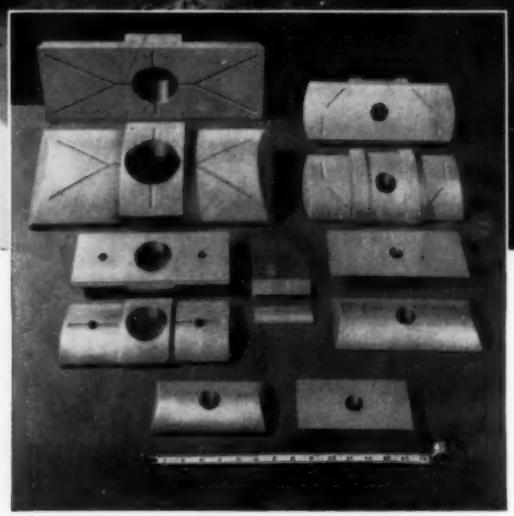
BROWN INSTRUMENTS

First in Controls

Production Steps Up Costs Step Down

See us in
Booths 44-45
Exhibit Hall
1956 Iron and Steel Exposition
Cleveland Public Auditorium
Cleveland, Ohio





. . . when you use AMPCO* SLIPPERS

THERE'S plenty of "plus value" in slippers cast of Ampco Metal. They're tough — have unusual resistance to wear. They withstand the tremendous impacts and shock loads of steel-mill operation without squashing out. They have high fatigue strength.

These properties mean lower costs for you — less downtime — longer runs without replacement.

You get these slippers in the form you need to meet your specific operation. They're available "cast-to-size" or as rough castings. "Cast-to-size Slippers" come either with tolerances of minus 0, plus 1/32; or plus 0, minus 1/32. Oil grooves are cast in, if you want them.

And that's not all. Ampco Metal's stamina, toughness, and corrosion resistance mean that it's ideally suited for cutting costs in other steel-mill applications, too — screw-down nuts, wear plates, flash-welder dies, pickling equipment. Get the whole money-saving story from your nearby Ampco field engineer or write us direct

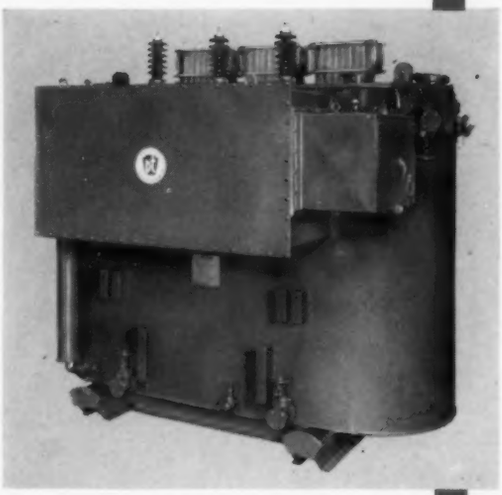
G-20

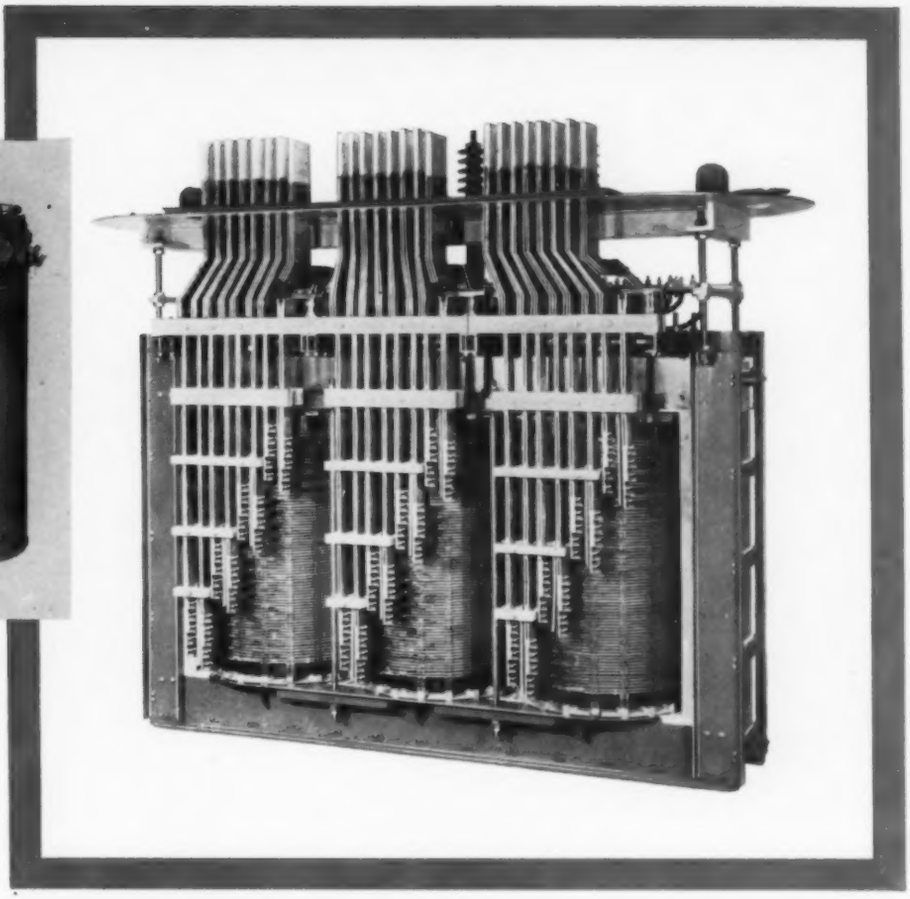
*Reg. U. S. Pat. Off.

AMPCO METAL, INC.

DEPT. IS-9, 1740 S. 38TH STREET
MILWAUKEE 46, WISCONSIN

West of the Rockies it's Ampco's Burbank Plant, Burbank, California





20,000-kva Pennsylvania Furnace Transformer. Three phase, 60 cycles, water-cooled. High voltage: 24,000 volts. Low voltage: 375 to 250 volts.

JUST 50 DAYS from order to shipment!

20,000 Kva PENNSYLVANIA FURNACE TRANSFORMER

Such speedy production of a furnace transformer of this size provides a striking demonstration of Pennsylvania Transformer Company's experience — and ability — in the highly challenging field of furnace transformer design and manufacture. In the case of this 20,000-kva unit, there were certain limiting dimensions to be met . . . low voltage bus work was required to match existing facilities . . . accessories and auxiliary equipment had to be located on the high voltage side or ends of the tank.

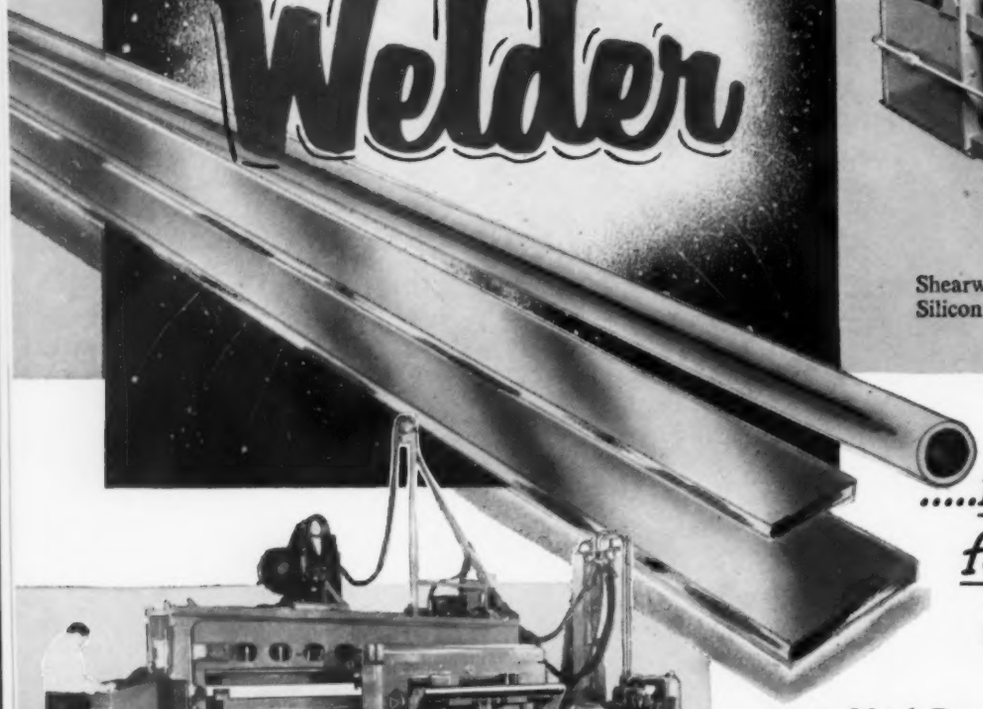
Working with transformer-design know-how dating back about half-a-century, Pennsylvania was able to meet these specific requirements, build and ship the much-needed transformer in exactly 50 days from the date the order was entered on the books. A feature of the unit is Pennsylvania's *exclusive helical low voltage winding* — which, since its introduction in 1936, has a record of *no breakdowns for more than 20 years.*

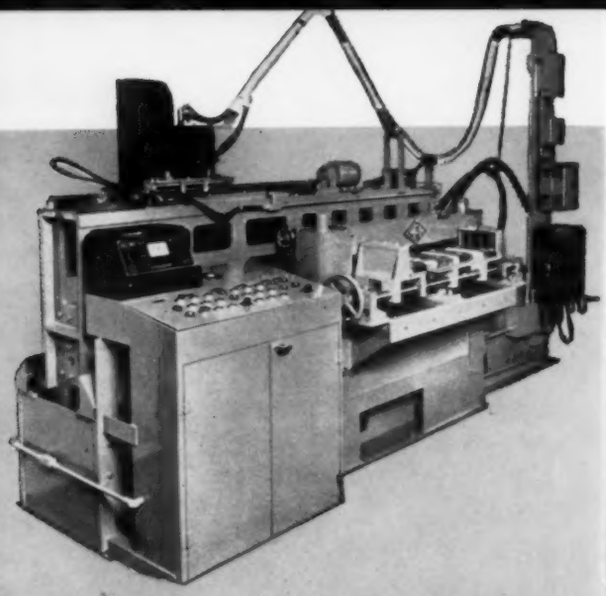
Other points worth noting are the separate, external compartments for the motor-operated tap changer and the tap-changer controls . . . and provisions for future forced-oil cooling with water-cooled heat exchangers.

Do you have a furnace transformer problem? Whether it involves short-term delivery or special design requirements, Pennsylvania will welcome the opportunity to serve you.

PENNSYLVANIA TRANSFORMER COMPANY
A McGraw Electric Company Division CANONSBURG, PA. Greater Pittsburgh District

THE NEW MPM Shear Welder





CONTINUOUS SILICON SHEET PRODUCTION

Shearwelder for coil build up line for 42" wide Silicon Steel from .015" to .030" thick.

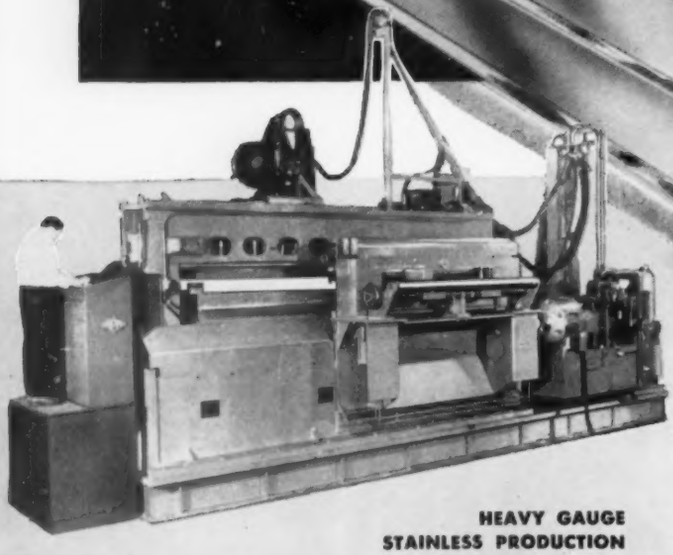
.....more automation for even faster Steel Production!

● Metal Processing Machine Company's new Shearwelders are outstanding because of their advanced design incorporating automatically sequenced operations.

Shearing and welding are performed at the same station with positive clamping right at the work area, thereby insuring perfectly aligned butt welds.

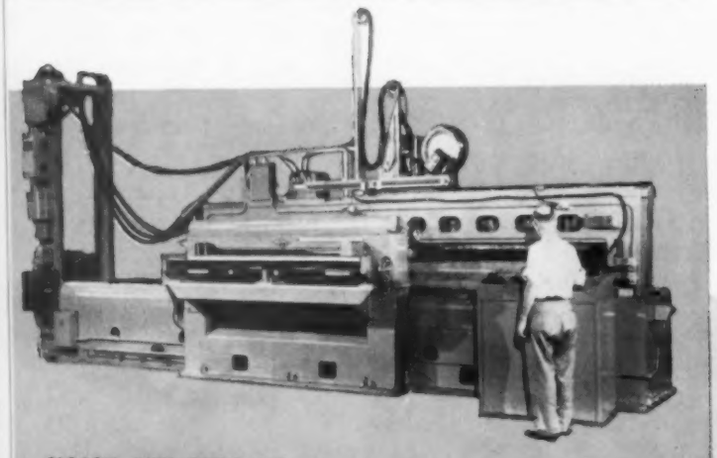
"M.P.M." welds are **extremely ductile,** permitting subsequent rolling, forming, or blanking operations. Weld joints are smooth and require **no trimming.**

Rugged construction is insurance for minimum maintenance and compact design saves floor space.



HEAVY GAUGE STAINLESS PRODUCTION

Shearwelder for butt welding 60" wide x .250" thick Stainless Steel.

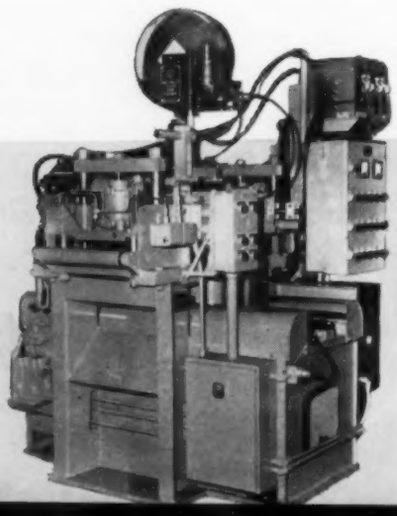


MAJOR COIL BUILD UP

Shearwelder for Carbon Steel coil build up line for .015" to .060" thick x 72" maximum width.

THE METAL PROCESSING MACHINE CO.

YOUNGSTOWN, OHIO



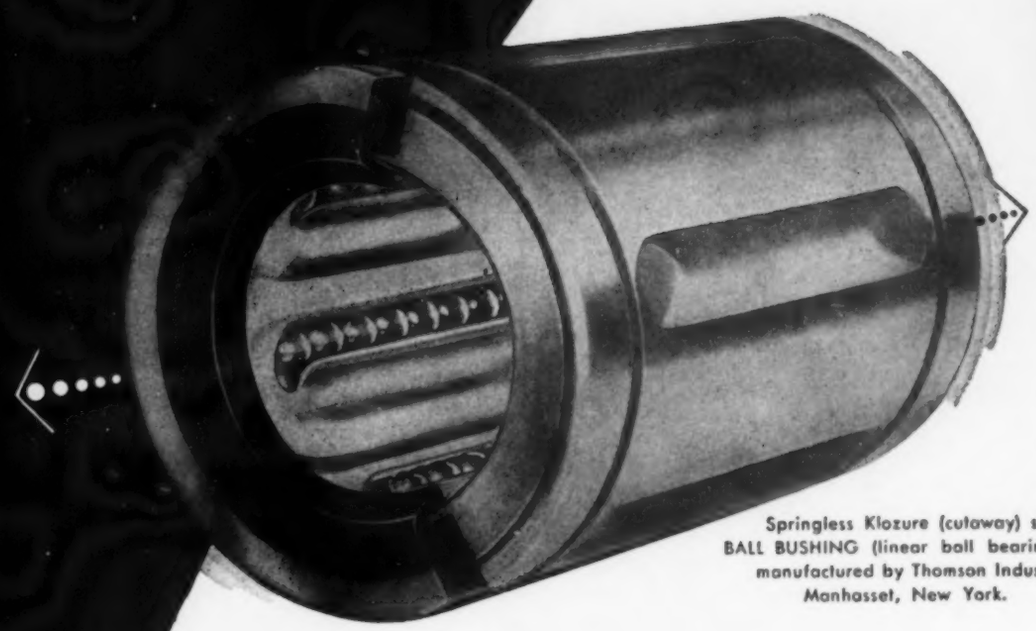
MPM

CONTINUOUS TUBE MILL PRODUCTION

Shearwelder used with strip looping device for splicing coil to coil to permit continuous production of tube mill.

10065

ONE OF THE GARLOCK 2,000



Springless Klozure (cutaway) shown on a BALL BUSHING (linear ball bearing) manufactured by Thomson Industries, Inc., Manhasset, New York.

First Choice

FOR LINEAR MOTION, TOO!

Klozure* Oil Seals Protecting bearings from dust and other contamination is as important in linear applications as it is in rotary bearing applications. That's why Thomson Industries, selected Garlock Klozure Oil Seals Model 71-A for their linear ball bearing. Thomson found that the unique design of the 71-A and its synthetic rubber sealing element made it ideal for their limited space, low pressure, grease retaining application.

Let us show you how one of "the Garlock 2,000" can help you . . . you can choose from two thousand different styles of packings, gaskets, and seals to meet all your needs. It's the only *complete* line . . . it's one reason you get *unbiased* recommendations from your Garlock representative. Call him today or write for Klozure Catalog 10.

*Registered Trademark

THE GARLOCK PACKING COMPANY, Palmyra, New York

For Prompt Service, contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Rubber Expansion Joints

engineering teamwork plus

NBD DESIGN ANALYSIS

adds cooling efficiency and economy

to blast furnace operation

The ideas came from customers.

Practical application of the ideas into a design was NBD's job.

Teamwork between NBD and customer engineering made it possible.

The result: a cleanly designed, vertical baffle bosh plate that eliminates the possibility of entrapped air and allows faster water circulation for more even, more efficient cooling. Its rectangular design adds economy, eliminating the need for special brick shapes.

We call this Design Analysis—*where you use NBD's more than 80 years of engineering and casting background, plus our research and production facilities, to prove ideas and make a design practical.* This is NBD's heavy experience with blast furnace copper and bronze paying off for you.

Right now you may have an idea which needs only a slight twist to make it practical. NBD may provide the twist you need. Call or write us to talk about it.

Pattern equipment for all bosh plate designs and sizes is maintained at NBD's Meadville, Pa., plant.

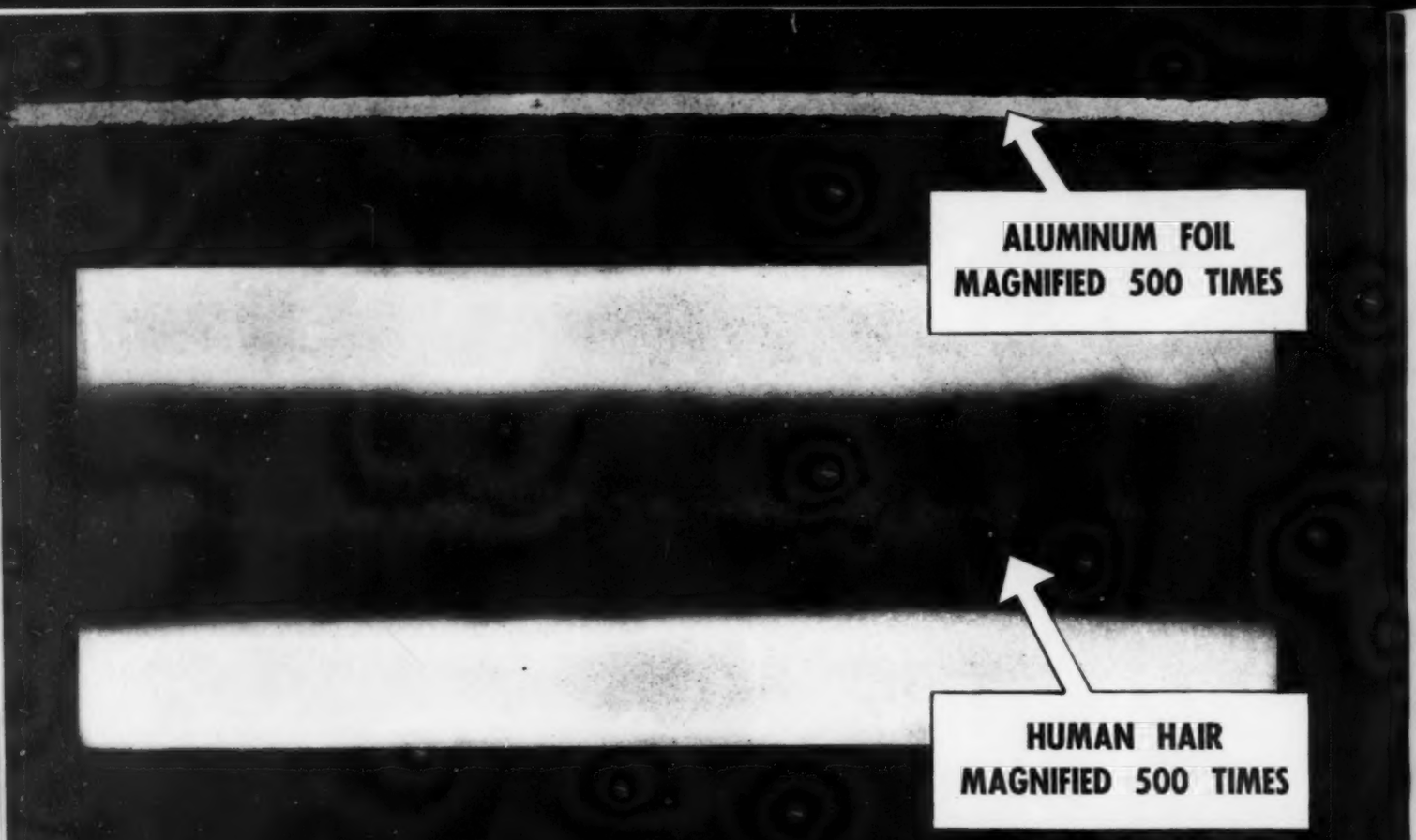
AMERICAN Brake Shoe COMPANY

NATIONAL BEARING

NBD VERTICAL-BAFFLE BOSH PLATE FEATURES

1. Vertical baffles enable positive inspection, assuring clean casting. Also permit faster water circulation.
2. Entrapped air expells through cored relief in top side of baffle at butt end of plate and the high outlet discharge.
3. Easy to backflush.
4. Uses standard brick shapes.

G DIVISION 4930 Manchester Ave., St. Louis 10, Missouri
Box 458 Meadville, Pennsylvania



General Electric d-c drives help

Roll aluminum 1/10 the thickness of human hair

A GENTLE TOUCH—Rolling high-quality aluminum to 1/10 the thickness of a human hair takes a gentle touch. Doing it 24 hours a day, six days a week demands sturdy, reliable equipment. To obtain this combination of sensitivity and dependability Republic Foil and Metal Mills, Danbury, Conn., has installed five General Electric Speed Variators on their pay-off drives.

REDUCED DOWN-TIME—Mr. James D. Post, Vice President in Charge of Operations, reports, "The General Electric Speed Variators provide more constant tension and steady acceleration. As a result, down-time and maintenance have been reduced on this delicate work. We also like the way they stand-up under continuous operation. Our satisfaction is manifest in a duplicate order for our No. 5 mill."

THREE COMPONENTS of G.E.'s Speed Variator are shown installed on the pay-off drive at Republic Foil and Metal Mills.

SPLIT-SECOND RESPONSE—General Electric Speed Variators are proving the answer to a variety of difficult metal rolling and slitting applications in brass, aluminum, and steel. Providing smooth, steady acceleration and split-second response to control signals, they can meet the most exacting drive requirements.

ENGINEERED TO YOUR SPECIAL NEEDS—The Speed Variator conversion unit comes assembled, wired and tested... ready to be installed on your a-c system. General Electric engineers will be glad to help you in making the most effective use of these drives. Please call your G-E Apparatus Sales Office or write for bulletin GEA-6127. *Direct Current Motor and Generator Department, General Electric Company, Erie, Pennsylvania.* 820-2

Progress Is Our Most Important Product

GENERAL ELECTRIC

Personnel News...

C. M. White, president and chief executive officer of Republic Steel Corp., has been elected chairman of the board of directors and continues as chief executive officer. He is succeeded as president by **T. F. Patton,** assistant president and first vice president. The change in the corporation's top management followed the retirement by 79-year-old steel veteran **T. M. Girdler** from the offices of chairman and director which he has held since Republic was organized in 1930. **Norman W. Foy,** vice president in charge of sales, was elected to succeed Mr. Girdler as director.

The retiring chairman became foreign sales engineer for the Buffalo Forge Co. in 1901. A year later he entered the steel business and was successively with Oliver Iron and Steel Co., Colorado Fuel and Iron Co., and Atlantic Steel Co. In 1914 he joined Jones & Laughlin Steel Corp. as assistant general superintendent and rose to the presidency. In 1929 he left Jones & Laughlin to aid in the organization of Republic Steel Corp. In 1930, when the new corporation was organized, he became chairman of the board and also served as president until 1937.

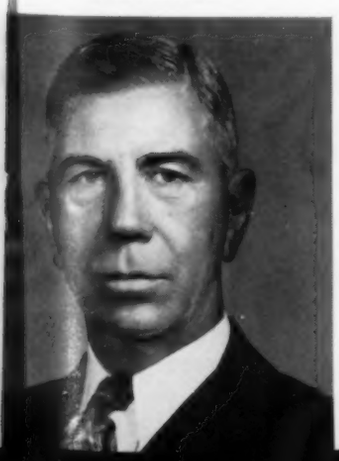
Mr. White started his career in steel in 1913 as a machinist helper with the American Bridge Co. He later worked at Jones & Laughlin as a millwright helper in the sintering plant. Two years later he had become plant superintendent. In 1927 he became assistant general superintendent of the Aliquippa Works and two years later general superintendent. He joined Republic in 1930 as assistant vice president of operations. In 1935 he was made operating vice president and directed Republic's extensive war-time production and plant expansion. Ten years later, in 1945, Mr. White became Republic's president.

Mr. Patton, Republic's new president joined Republic as general counsel in 1936. In 1943 he was elected a director and in 1944 was made a vice president. In 1953 he gave up the responsibilities of general counsel when he was named assistant president and first vice president. In this new capacity he has had general supervision over a large segment of the company's operations.

R. L. Gray, executive vice president of Armco Steel Corp., has been elected president, succeeding **W. W. Sebald** who will continue in an executive capacity as vice chairman of Armco's board of directors. Mr. Sebald also succeeds **Charles R. Hook,** Armco's chairman of the board, as chairman of the executive committee. Mr. Gray started his career with a steel forgings company in the St. Louis area, and soon became works manager. When the plant was acquired by the Laclede Steel Co., he rose to the position of chief engineer. In 1923, he went to Kansas City as chief engineer of the Kansas City Bolt and Nut Co. Two years later he was named assistant to the president. In 1925 the company name was changed to Sheffield Steel Corp., and Mr. Gray was elected vice president. When Sheffield became an Armco subsidiary in 1930, he was made its president. In 1940 he was elected to the Armco board of directors, and in 1954, following Sheffield's integration as a division of the parent company, he was elected executive vice president of Armco.

Herbert F. Byrne was appointed vice president of production planning and **Louis J. Rohl** was appointed vice president and chief metallurgical engineer of United States Steel Corp. These are both newly created positions. At the same time it was announced that **Joseph M. Greer** was promoted to general manager—production planning for the corporation. Before coming to U. S. Steel in 1942 as priority administrator, Mr. Byrne's business career was principally in automobile manufacturing and distributing. He was made assistant to general manager of production planning for Carnegie-Illinois Steel Corp. in 1944 and director of production planning for U. S. Steel Corp. of Delaware in 1946. He has been general manager of production planning of United States Steel since 1953. Mr. Rohl joined U. S. Steel at South Works, Chicago, Ill., in 1917. He advanced through the positions of product metallurgist, assistant superintendent of alloy production, assistant superintendent of the production department, and superintendent of production. In 1933 he became assistant to the general superintendent of South Works, and later that year he was appointed assistant manager of the Chicago District metallurgical division. In 1943 he was made manager of this division and was promoted to the position of assistant chief metallurgical engineer in 1947. Later that year he was made chief metallurgical engineer, operations—steel. Mr. Greer joined U. S. Steel in the industrial engineering department of Duquesne Works in 1937. He was transferred to Irvin

C. M. WHITE



T. F. PATTON

R. L. GRAY

W. W. SEBALD

HERBERT F. BYRNE

LOUIS J. ROHL

R. C. COLBAUGH

C. W. IAMS

Works in 1940 as assistant superintendent of production planning. In 1942 he was made staff assistant in the production planning department of the Delaware Corp. and in 1944 assistant to the general manager of production planning of Carnegie-Illinois Steel Corp. Mr. Greer was transferred to Gary Sheet and Tin Mill in 1948 as superintendent of production planning. He returned to Pittsburgh in 1951 as assistant to general manager production planning and in 1954 was promoted to his present position of assistant general manager of production planning of United States Steel Corp.

R. C. Colbaugh has been appointed assistant vice president of industrial engineering of United States Steel Corp. At the same time it was announced that **C. W. Iams** will succeed Mr. Colbaugh as assistant to general manager, operations—steel. Mr. Colbaugh joined U. S. Steel as a metallurgical observer at Duquesne Works in 1935. The following year he became an industrial engineer at the plant and in 1937 was transferred to Edgar Thomson Works in the same capacity. He was made plant industrial engineer at Edgar Thomson in 1939 and served in this capacity until 1942 when he was transferred to the general office in Pittsburgh as manager of the service bureau. He was made manager of the cost bureau in 1944 and assistant chief industrial engineer in 1950. A year later he was appointed assistant to general manager, operations—steel, the position he held at the time of his present appointment. Mr. Iams came to U. S. Steel in 1933 as a metallurgical observer at Homestead Works. He was made assistant plant industrial engineer in 1935 and plant industrial engineer at Clairton Works in 1936. He was transferred to the Pittsburgh general office in 1939 on special assignment. In 1942 Mr. Iams was made plant industrial engineer at Irvin Works, returning to the Pittsburgh office in 1944 as Pittsburgh district industrial engineer. In 1948 he left the corporation to become an operating executive with Firth-Sterling Steel Co., returning in 1951 as assistant to general superintendent of Gary Sheet & Tin Mill. He was transferred in 1953 to Gary Steel Works as assistant to general superintendent, the position he held at the time of his recent appointment.

Jack H. Smith was named director of the Air Control and Research Department of Kaiser Steel Corp. For the past six years he has been technical engineer for the company's program of controlling stack emissions throughout the plant. He joined Kaiser Steel in 1949 as a production assistant.

Robert H. Hudson has been named to succeed **David C. Ladd** as production metallurgist at the Timken Roller Bearing Co.'s Gambrinus Plant. He was formerly forge shop metallurgist in the mill metallurgical group. Mr. Ladd has been promoted to metallurgical engineer in Production.

Wallace I. Marsteller was appointed superintendent of open hearth bloom and billet mills at Republic Steel Corp.'s Youngstown District steel plant. He replaces **J. C. Edie** who has retired after 40 years' service with

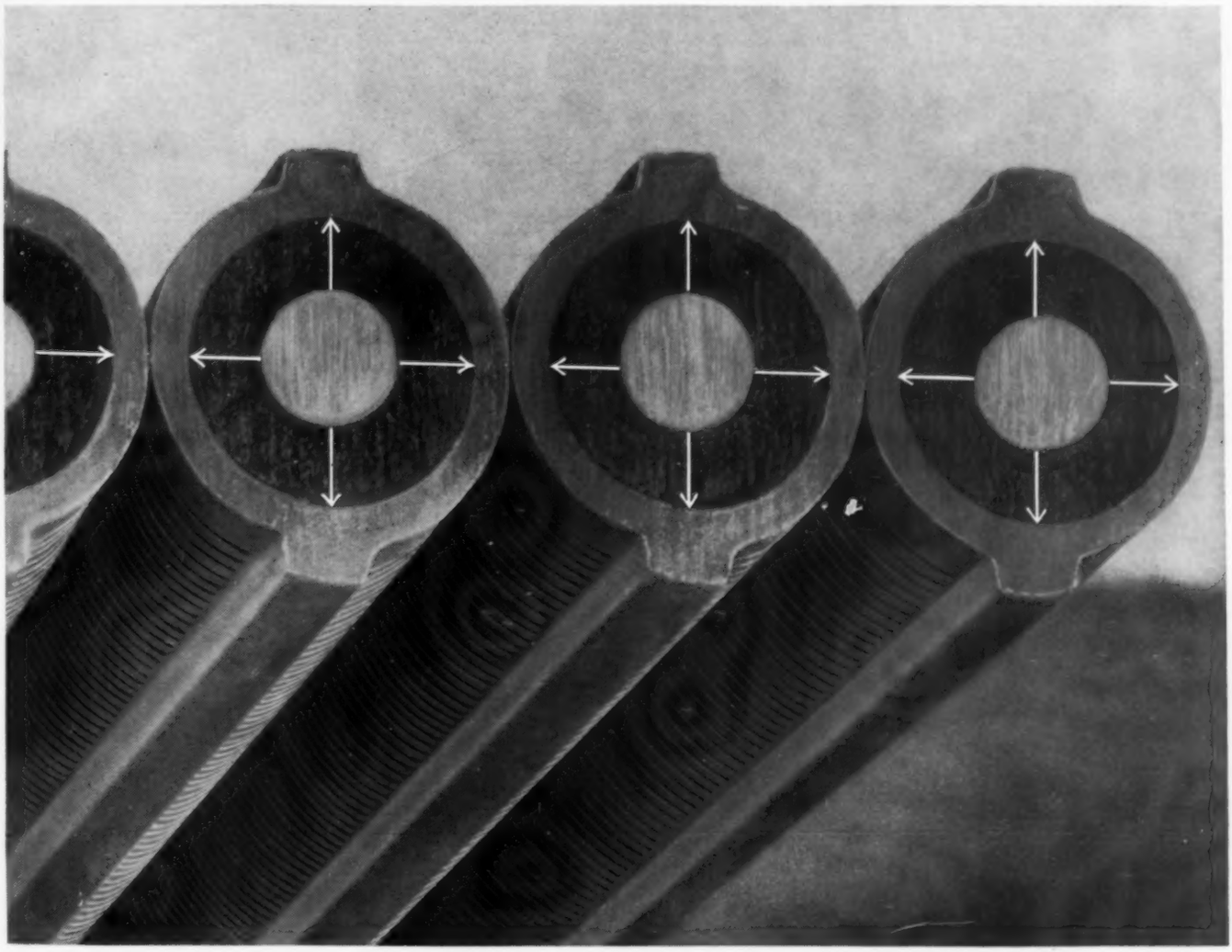
WALLACE I. MARSTELLER

Republic. Mr. Marsteller was promoted from the position of foreman. He has been with Republic since it was organized in 1930 and for the previous seven years was affiliated with a predecessor company.

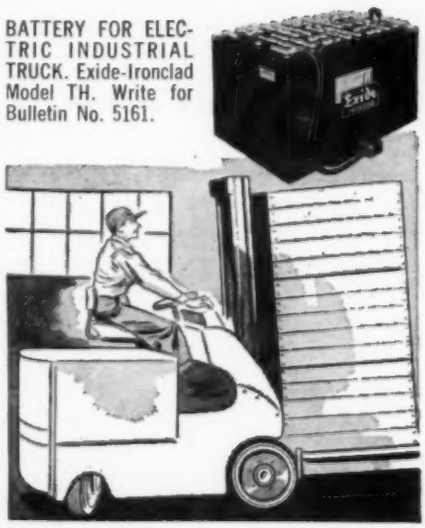
George W. Bretz, assistant vice president of Air Products, Inc., has been transferred to Los Angeles, Calif. He will assume responsibility for administrative duties on the West Coast. Mr. Bretz replaces **Carl R. Anderson,** vice president, who will return to the Allentown area. Mr. Anderson will head-up the newly created operation, construction and service division.

EXIDE-IRONCLAD BATTERIES

For electric industrial truck operation



Power tubes expand without shedding — preserve battery life



BATTERY FOR ELECTRIC INDUSTRIAL TRUCK. Exide-Ironclad Model TH. Write for Bulletin No. 5161.

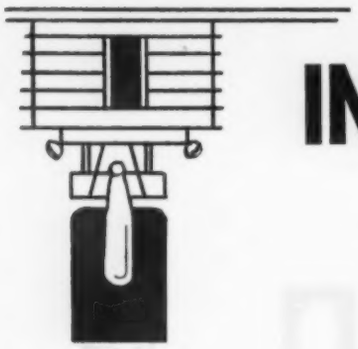
Every time you discharge a storage battery, the active material on the positive plates expands. But the plate grids don't expand. This is basic.

On most batteries, the expanding active material tends to shear off from the nonexpanding grid every time the action takes place. But this can't happen in the Exide-Ironclad Battery. The reason is simple.

Active material is formed concentrically around the spinelike grid and held inside the plastic tubes. Expansion is predominantly in an outward direction—hence no shearing. Active material remains firmly locked to the underlying grid structure. And the flexible plastic tubes yield and take up as needed.

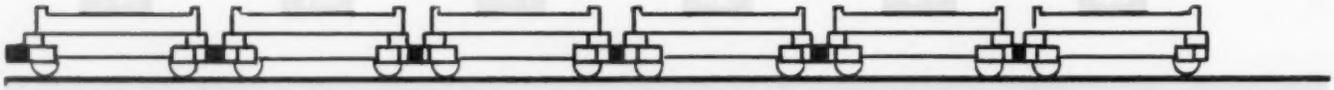
This extra protection against shedding of active material is only one of the many reasons for the long life of Exide-Ironclad Batteries. When you order heavy duty batteries, or the equipment requiring them, be sure to specify Exide-Ironclad. Write for detailed bulletin. Exide Industrial Division, The Electric Storage Battery Company, Philadelphia 2, Pa.

Exide®



INCREASE INGOT OUTPUT

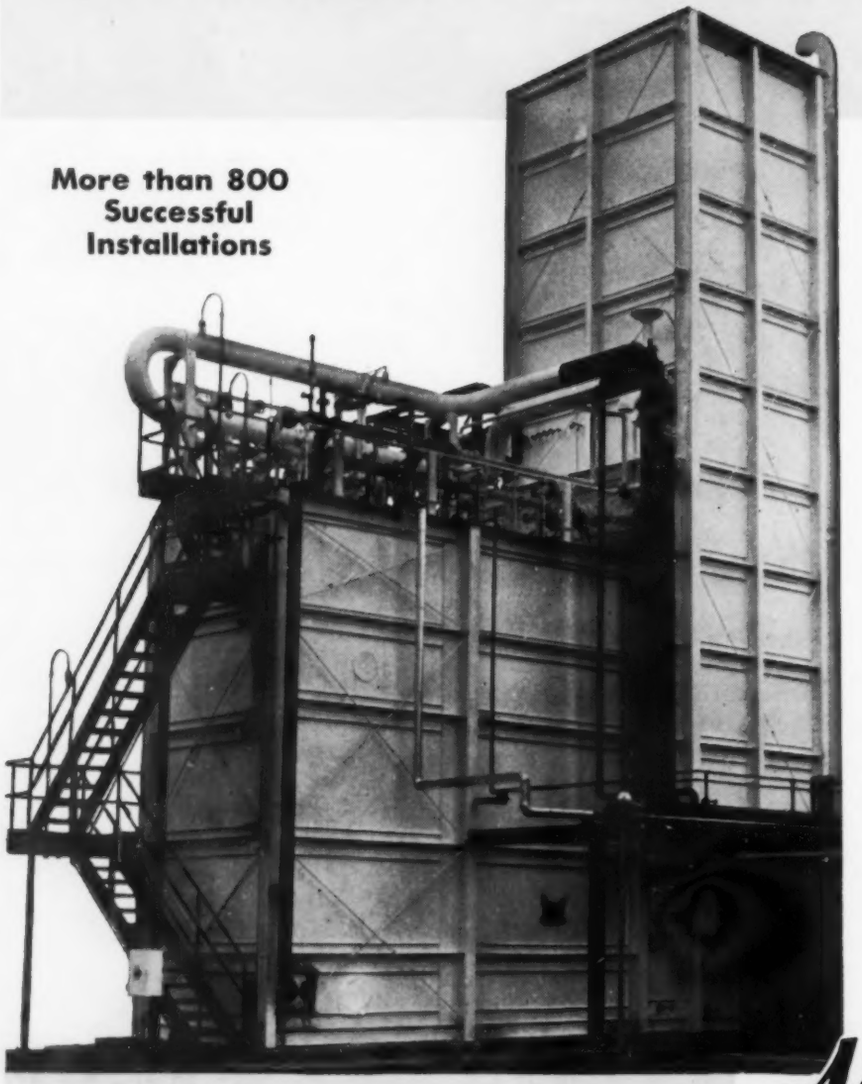
without capital investment



with

"ON-LOCATION" OXYGEN GENERATORS

More than 800 Successful Installations



Full utilization of oxygen in blast furnaces, open hearths and steel converters offers the Steel Industry the most economical means of increasing ingot output. And, of course, a captive generator is essential for the use of oxygen in adequate quantity.

We will furnish and install an "On-Location" oxygen and/or nitrogen generating station to suit your present and expanding oxygen requirements —on a lease basis (you can operate and maintain or Air Products will operate and maintain), with price guaranteed at all levels of consumption, *without capital investment by you.*

We design and manufacture:
Generators for unlimited quantities of oxygen and nitrogen regardless of size, purity or cycle.

If you will send us details regarding your requirements, we will give you a close estimate of the savings you can expect with Air Products "On-Location" Oxygen and/or Nitrogen Generators installed at your plant.

LOW COST OXYGEN...NITROGEN

Air Products
INCORPORATED
Dept. P, Box 538, Allentown, Pa.

Wynne C. Walston has been appointed contracting manager for the Cleveland District of the American Bridge Division, United States Steel Corp. Mr. Walston succeeds **Charles A. Harris,** who has been transferred to New York.

WYNNE C. WALSTON

G. H. Rearick, Milwaukee plant manager of the Babcock & Wilcox Co.'s Tubular Products Division, has been named to the staff of **W. J. Thomas,** company vice president. Appointed to succeed Mr. Rearick as Milwaukee plant manager is **Norman E. Wenzel,** assistant plant manager. Mr. Rearick has been with B&W since 1916. Before his appointment to the Milwaukee post early in 1955, he had been superintendent of the division's welded tubing plant in Alliance, Ohio. Mr. Wenzel held numerous management posts with Globe Steel Tubes Co. before that firm was acquired by Babcock & Wilcox in 1955. At that time he was made assistant plant manager, after having served in various supervisory positions.

Russell E. Bryant has been appointed by Wagner Electric Corp. to manage the electrical division of its Los Angeles, Calif., branch. He succeeds **Leonard G. Tandberg** who retired September 1 after nearly 47 years with Wagner. Mr. Bryant was a sales engineer in the Wagner Pittsburgh office from 1942 to 1949 and for the past seven years has been manager of the company's Buffalo sales and service branch. He was secretary of the Buffalo District of AISE during 1954 and 1955.

B. R. Stratton has been named manager of Atlanta, Ga., district sales office of Cutler-Hammer, Inc. Mr. Stratton, former branch manager at Tulsa, Okla., has been with the firm in an engineering sales capacity since 1936.

Hans Guenther Sohl, president of the August Thyssen-Huette A.G., has been elected chairman of West Germany's Federation of Iron and Steel Industries.

Admiral Ben Moreell, Chairman of the Board, Jones & Laughlin Steel Corp. will be awarded the John Fritz Medal on October 17. The award is sponsored jointly by the American Society of Civil Engineers, the American Institute of Mining, Metallurgical and Petroleum Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers. Presentation of the gold medal and certificate signifying the honor will be made in Pittsburgh during the national convention of the American Society of Civil Engineers. The John Fritz Medal Board of Award, constituted of sixteen representatives of the sponsors, four from each organization, voted the award to Admiral Moreell as a "distinguished engineer and noted officer; builder of Naval works in war, and in peace eminent industrialist and civic leader; devoted servant of church and country."

Daniel A. Sutch was named president of Ramseyer & Miller, Inc., Iron and Steel Industry Consultants. He succeeds **C. F. Ramseyer** who becomes chairman of the board. In addition, **William Shapiro** and **William Kowalsky** were named vice presidents. **J. R. Miller** continues as executive vice president.

Clarence H. Sleeman, assistant manager of the Minnesota Ore Division of Jones & Laughlin Steel Corp., has been appointed chief mining and development engineer of the Ore Mines and Quarries Division. He joined J&L in 1946 as a mining engineer at the Hill Annex Mine at Calumet, Minn., and was named assistant manager of J&L's Minnesota Ore Division in 1954, with headquarters at Virginia, Minn.

Eric B. Insley and **James N. McEntee** have been appointed manager and sales manager respectively of the newly created Materials Handling Division, Los Angeles Sales and Service Branch of the Yale & Towne Manufacturing Co. The two appointees were last associated with the Insley-McEntee Equipment Co., Yale sales and service representative in Rochester, N. Y.

John P. Walsh has been appointed sales engineer of Pittsburgh Engineering Co. He was formerly associated with Morgan Engineering Co., Youngstown Foundry & Machine Co., and Wean Engineering Co.

G. H. REARICK

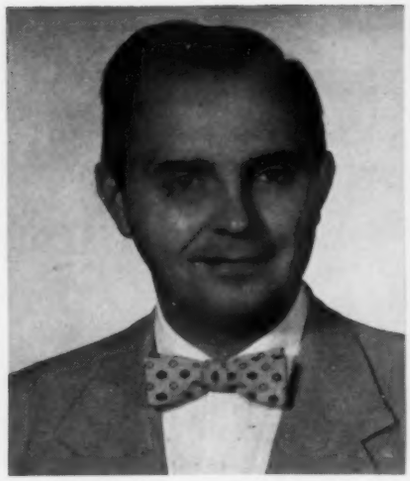
RUSSELL E. BRYANT

B. R. STRATTON

HANS GUENTHER SOHL

S. E. GEWIN

WALTER MESSNER



ANDREW J. SOFRANKO

RAY E. KRANZ

S. E. Gewin was named district manager of the Bristol Co.'s Chicago office. Mr. Gewin's successor as manager of the St. Louis office will be **Walter Messner.**

Andrew J. Sofranko has been appointed sales engineer by the Mannesmann-Meer Engineering and Construction Co., Inc. Mr. Sofranko originally joined the firm as a machine designer, and has since specialized in the development and installation of special equipment, especially drawbenches and other cold finishing equipment.

Ray E. Kranz, sales engineer of the Steel Mill Division, Surface Combustion Corp. in the Philadelphia area, has been transferred to the Pittsburgh, Pa., sales office. In his new assignment, Mr. Kranz will assist the Pittsburgh district manager, **Don Martin.**

H. A. Besocke has been appointed manager of De Laval Steam Turbine Co.'s new sales branch office in Moline, Ill. Mr. Besocke has served in De Laval's Chicago district office since 1949. The new office is located at 1610 Fifth Avenue, Moline, Ill.

C. J. Burke was promoted to sales manager and **E. J. Fogel** was promoted to manufacturing manager of Westinghouse Electric Corp.'s newly-created industrial gas turbine department at the Lester, Pa. plant. **T. J. Putz** will continue in his capacity of engineering manager for industrial gas turbines.

Carl F. Hayden, president and treasurer, **Kenneth C. Hayden,** vice president and director of sales, and **T. L. Dahlberg,** engineer, all of Hayden and Co. of Chicago, Ill., have been appointed Chicago District Representatives of the Rust Engineering Co.

Earl V. Akerlow has been appointed an assistant division manager in the Engineering Department of Kaiser Engineers. Since 1952, he has been principal and project engineer, respectively, in Kaiser Engineers' Oakland Engineering offices. Previously, he was a consulting engineer for Fairbanks-Morse at Pomona, Calif.

John P. Holt was named executive assistant to vice president—sales of Basic, Inc. Before joining Basic in 1950 he served in a variety of open hearth and electric furnace capacities, last of which was superintendent of melting at the Midvale Co. Also announced is the appointment of **Charles J. Tyson, Jr.** to Basic's sales and service staff. Prior to joining the company he was associated for nine years with Bethlehem Steel Corp.

Donald W. Walker has been appointed foil product manager for Kaiser Aluminum & Chemical Sales, Inc. Mr. Walker was formerly pig and ingot product manager for the company. He will be succeeded by **A. V. Lorch,** who has been serving as assistant pig and ingot product manager since 1954.

James B. Wilkie was named manager of the gage division of the Pratt & Whitney Co. Mr. Wilkie joined Pratt & Whitney in 1935 and served for a time as a

JAMES B. WILKIE

sales engineer in the company's Detroit, Mich., office and later became chief gage sales engineer in Hartford, Conn. Since 1955 he has been assistant manager of the cutting tool and gage divisions.

Richard G. Lang has been appointed a sales representative at the Chicago district office of Heppenstall Co. Mr. Lang joined the company in 1948 at the headquarters in Pittsburgh. In 1950 and 1951 he served with W. P. Wooldridge Co., Pacific Coast representative of Heppenstall Co. From 1951 until his new appoint-

Sinter machine drive gear and sprocket

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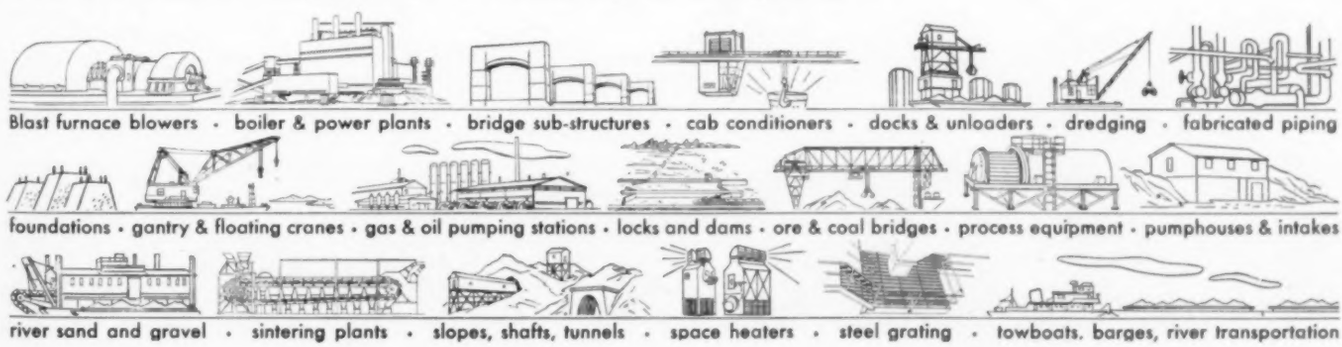
During the past 45 years, Lurgi has made over 250 sintering plant installations to qualify as Europe's foremost designer of all types of equipment for the treatment of low grade ore. And over a similar period, Dravo has been designing and fabricating special-purpose and heavy duty equipment.

An exclusive license agreement combines Lurgi design experience with Dravo's extensive engineering and construction facilities to provide sintering equipment adapted to the needs of American industry. Dravo is presently engaged in constructing a number of iron ore sintering plants which will have an aggregate annual capacity of over 11,000,000 tons.

Engineering and planning assistance is available to help you develop equipment or complete plants for sintering, pelletizing or other related ore processing and preparation. Write to Dravo Corporation, Dept. S-100, Pittsburgh 22, Pa.

DRAVO
CORPORATION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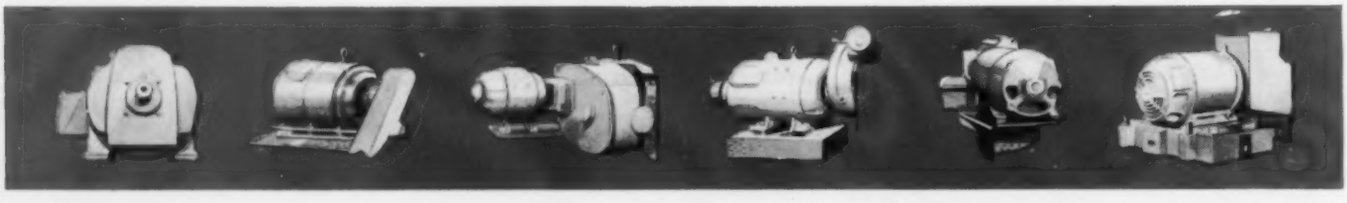


ment, he was a sales engineer for Heppenstall Co.'s Detroit district office.

Cody M. Murray was named manager of industrial relations for the Electric Storage Battery Co. He formerly was assistant to the general manager of the company's Stokes Molded Products Division, Trenton, N. J.

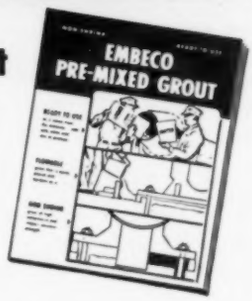
Ralph C. Hanson, formerly of E. J. Lavino & Co., has become associated with the Ramtite Co. Mr. Hanson will work out of the company's Pittsburgh office as a special representative co-ordinating sales.

Paul E. Masters was appointed welding engineer of U. S. Steel's American Bridge Division. Mr. Masters began his career with American Bridge in 1942 as a draftsman in the mechanical engineering department. In 1943 he was made assistant to welding engineer, and in 1955 was promoted to engineer of tests of American Bridge Division. In 1956 he was promoted to senior project engineer, facility and specialty engineering department of the American Bridge Division, the position he held until his recent appointment.

Edward J. Shages has been named vice president and manager of the cutting tool and gage divisions of the Pratt & Whitney Co., Inc. Mr. Shages has been associated with Pratt & Whitney in important posts for 27 years. Most recently he has been factory manager of the company's cutting tool and gage divisions and prior to that superintendent of manufacturing of its machinery division.

READ THIS GROUTING GUIDE

... before you Grout another piece of heavy equipment



Send for this *free* grouting guide which clearly illustrates 11 common machinery settings, methods of grouting and forming, and hot and cold weather grouting. Discussion covers proper mixing and placing of grout, reasons for using prepared, non-shrink grout, etc.

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the MASTER BUILDERS CO.
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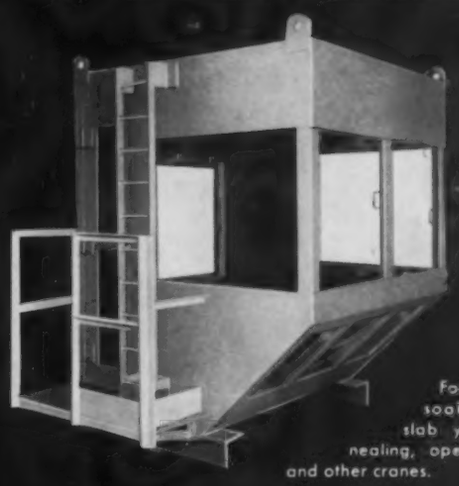
FULL VISION CRANE CABS by LINTERN



for Existing Cranes ... Many Advantages

Of our standard construction design, these cabs require a minimum of engineering, which is reflected in their moderate price.

Completely insulated with a minimum of thru-metal, they promote *quick cooling* with least strain on the air conditioning equipment, resulting in longer life.

They are installed with the smallest amount of down-time — an important saving. They offer maximum vision.

And we are delivering them faster, in many cases, than the buyers could engineer them.

In brief, Lintern Cabs offer you important advantages in engineering, installation, and operation. May we quote you?

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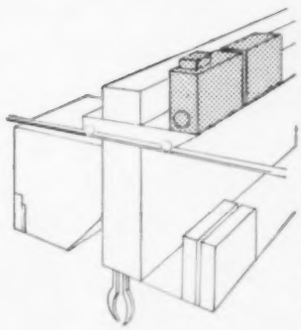

Although your temperatures may range up to 230° F. — or even higher — this Crane Cab Conditioner will provide satisfactory cooling in the cab.

Known as a Cascade System, the complete system combines two condensers (a low and a high stage). Both Condensers are located as high as possible on the trolley.

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Booths 93 and 94

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Regardless of size, weight or surface required, bring your finishing problems to the company most experienced in the brushing of metals . . . *The Osborn Manufacturing Company, 5401 Hamilton Avenue, Cleveland 14, Ohio.*

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What is the Bailey Building Block Method? It's using standardized Bailey measuring, transmitting, and controlling components and combining them into any system you need. Components can be added as needed . . . removed and reused elsewhere . . . recombined into another system when the need changes. It's flexibility plus!

It's all based on the simple fact that a Bailey instrument or control component doesn't care if the measured variable is fuel flow, percent oxygen, or furnace temperature, to pick just three examples. System components—transmitters, receivers, relays, selector stations, power units—are standardized for multi-purpose use.

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There are many exclusive features and advantages of the individual components used in the Bailey Building Block Method. And there's much more to the Building Block story itself.

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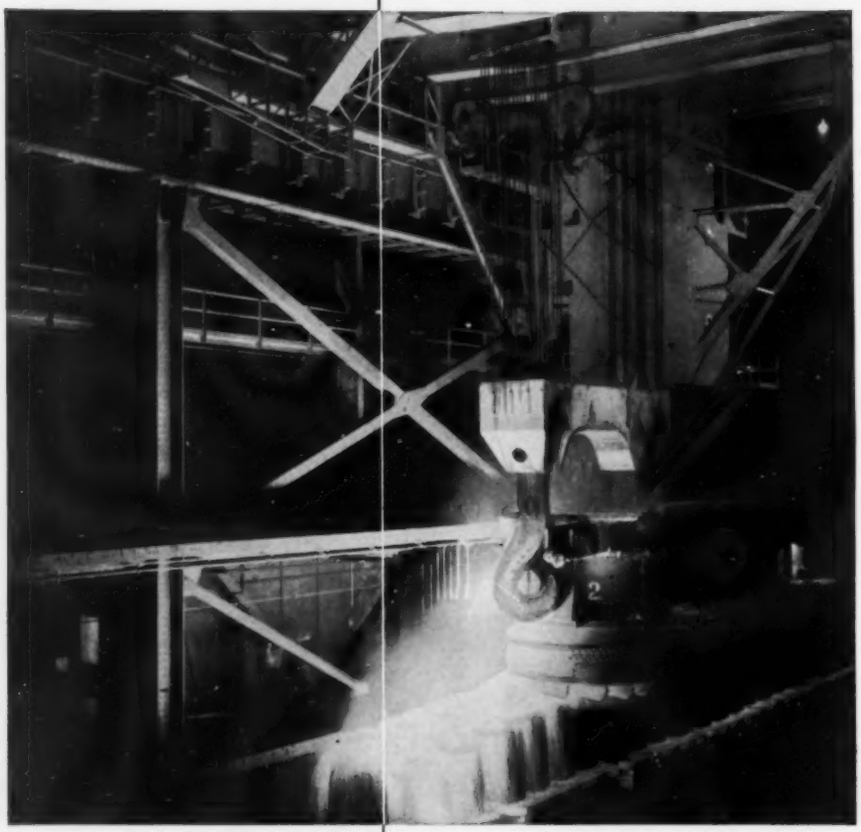
RESULTS IN: FLEXIBILITY, SIMPLICITY, ECONOMY

BAILEY METERS

Morgan cranes stop "on a dime"

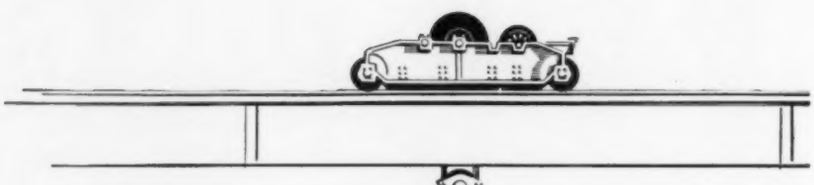


● BRAKING a Morgan crane under full load is as easy as stopping the family car.

Morgan hydraulic crane brakes provide maximum safety and pin-point accuracy in spotting heavy loads . . . another vital link in the chain of features that makes Morgan cranes best in the business.

Performance records prove that advanced design and heavy-duty construction of Morgan cranes make them less costly to operate and maintain. Let our representative show you how to save the most by buying the best . . . Morgan!

Positive action encourages operators to use the hydraulic brake rather than plug the motor.



The Morgan Engineering Company, founded in 1868, manufactures overhead electric traveling cranes, gantry cranes, charging machines, plate mills, blooming mills, structural mills, shears, saws, and auxiliary equipment.

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Check thermocouple circuits from your instrument panel during each heat. Save hundreds of hours inspecting and **needlessly** replacing thermocouples.

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SALTBATH	Aircraft-Marine Products, Inc. The Electric Auto-Lite Co. The Black & Decker Manufacturing Co.
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***THE RESTORER** detects and corrects thermocouple circuit failure **during** any heat treating or melting operation.

****THE LEAK-CHECKER** detects leaks in thermocouple protection tubes immersed in saltbath or other melting furnaces.

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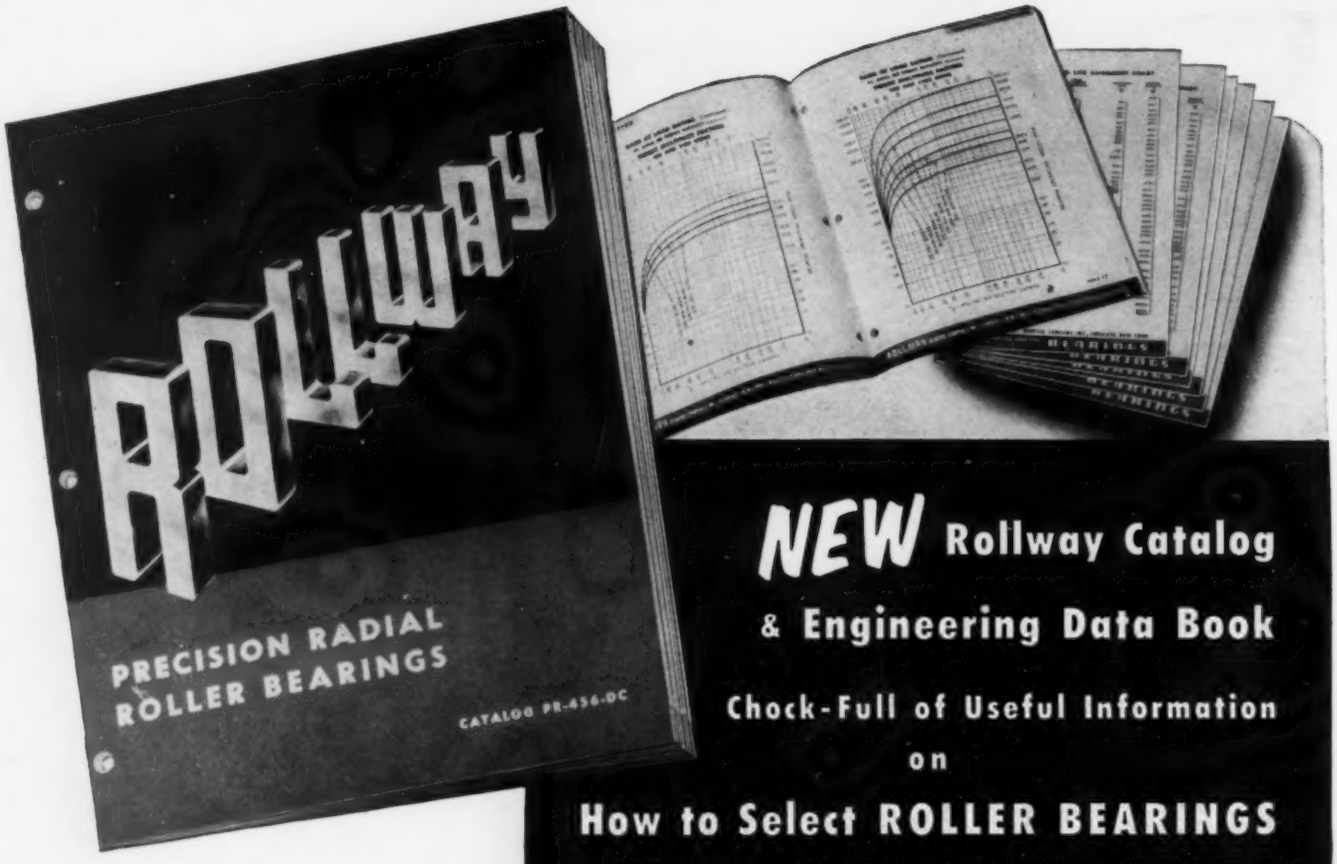

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- **Contains the following important data on precision radial roller bearings . . .**

CAPACITIES Detailed information on radial static capacities, radial dynamic capacities, and thrust capacities of cylindrical radial bearings.

Thrust capacities and radial dynamic capacities are given separately. Thrust load does *not* reduce radial capacity nor life expectancy of bearing: It is not necessary to calculate an "Equivalent Radial Load."

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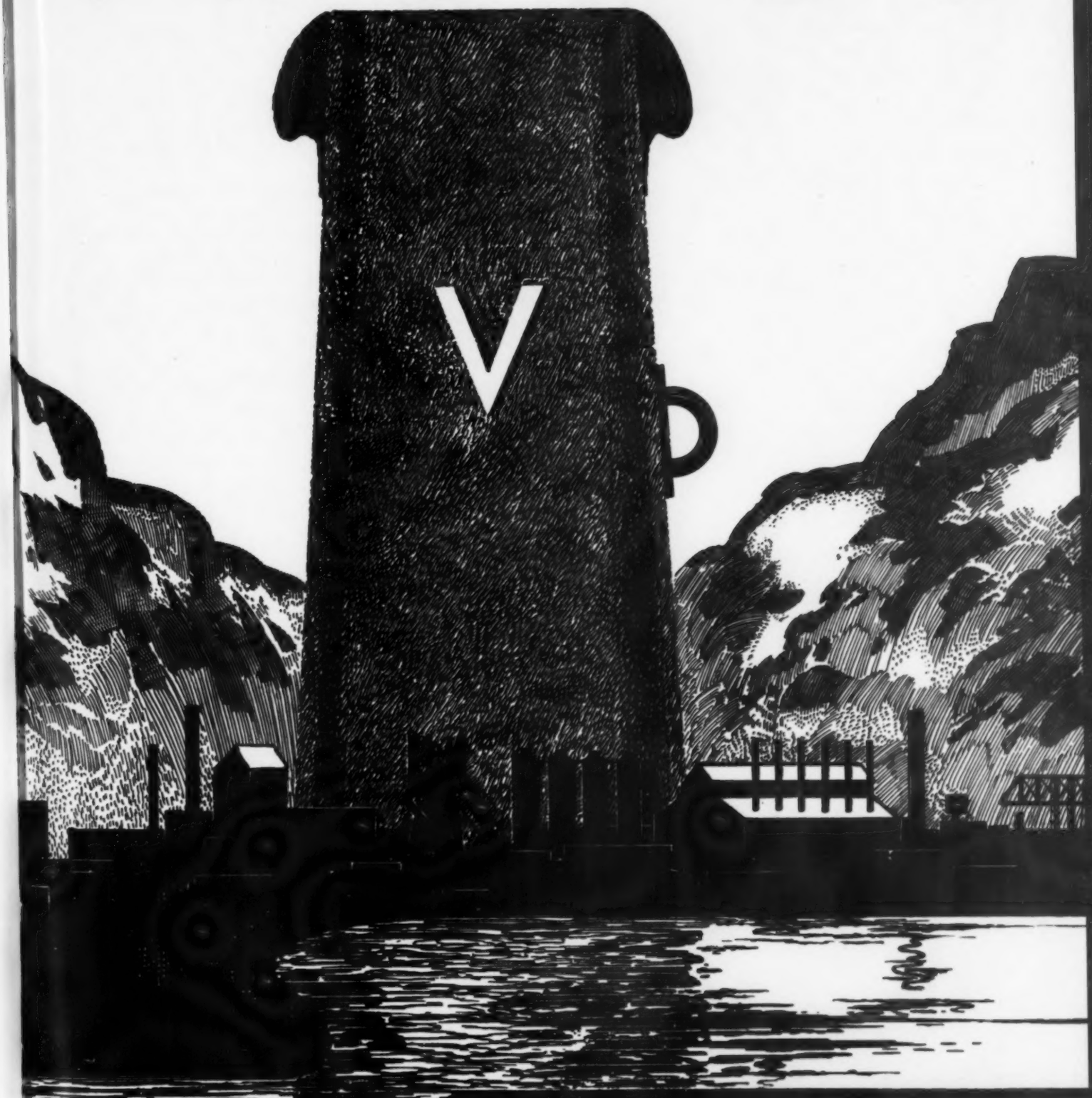
VALLEY



INGOT MOULDS

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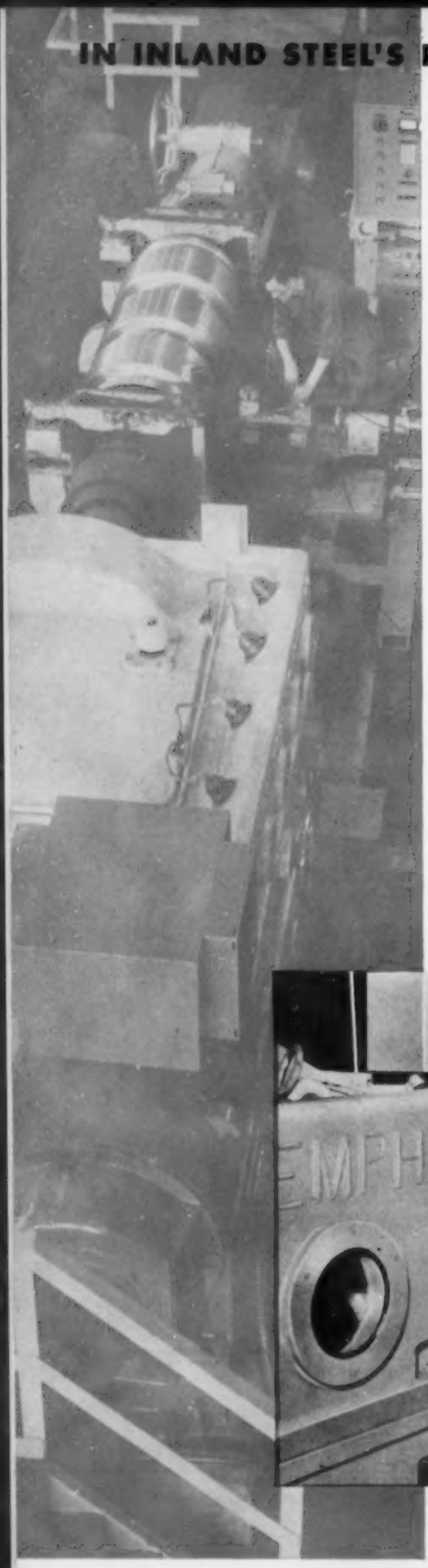


IN INLAND STEEL'S ROLL DEPARTMENT

New Mack-Hemp electronic contouring lathe removes metal at peak rates with .001" accuracy

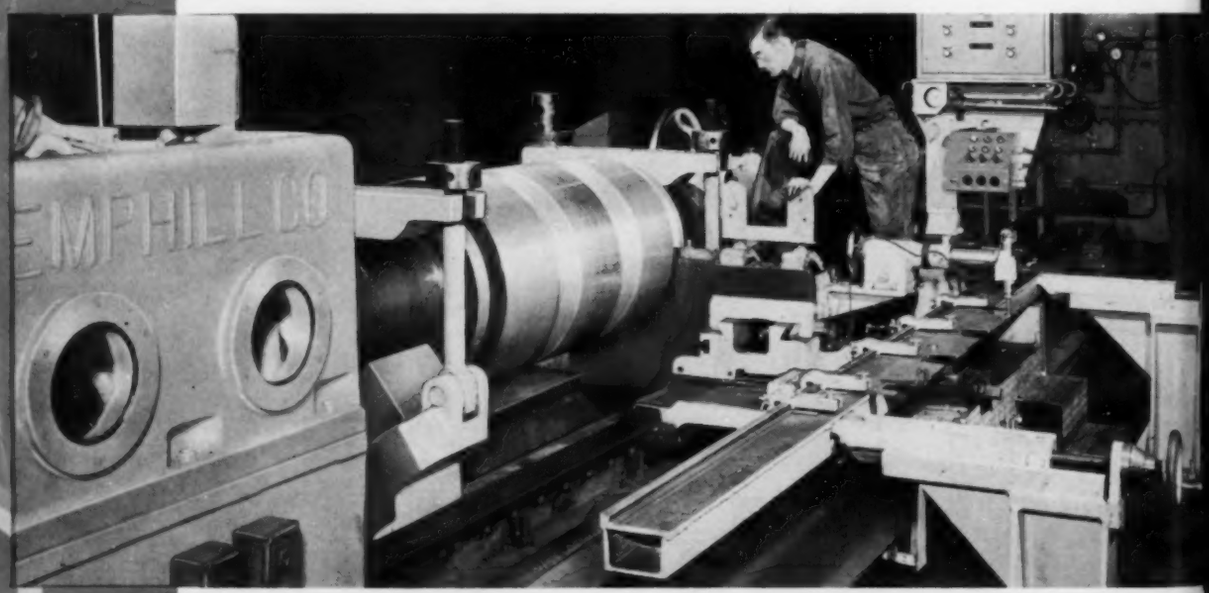
An electronic "pilot" guides this 48" Mackintosh-Hemphill contouring lathe recently installed in the Roll Department at Inland Steel Company's Indiana Harbor Works. It is so precise that the lathe can finish contours into a roll without deviating more than .001" from the pattern on the full-size template.

Stylus contact with the template controls the lathe's longitudinal- and cross-feed motors through electronic linkages. Thus, dual feed motion response of the tool holder carriage is instantaneous and smoothly continuous. Any conventional groove shape can be duplicated—it is even possible to make an accurate cut on a shoulder vertical to the axis of the roll.

But this precision of control is only one reason why the big lathe can turn shape rolls so rapidly. It has been designed and built to handle some of the heaviest torsional loads ever imposed on a lathe. For example:

> ***It can operate continuously through a ⅞" cut depth with feeds between .060" and .100", and with spindle speeds up to 62 RPM. It can turn rolls or forgings 50" in diameter and 18 feet long.***

If you are planning to install new large-roll turning capacity, you'll be wise to investigate these cost-cutting automatic contouring lathes. Write us today for complete information. They're available in 48", 60" and 72" sizes.



Inland's new 48" Mack-Hemp automatic lathe here is cutting passes into a new roll for a 3-high structural mill that rolls 15" I-beams. Hardness of the roll is 42 Shore.

MACKINTOSH-HEMPHILL
DIVISION OF
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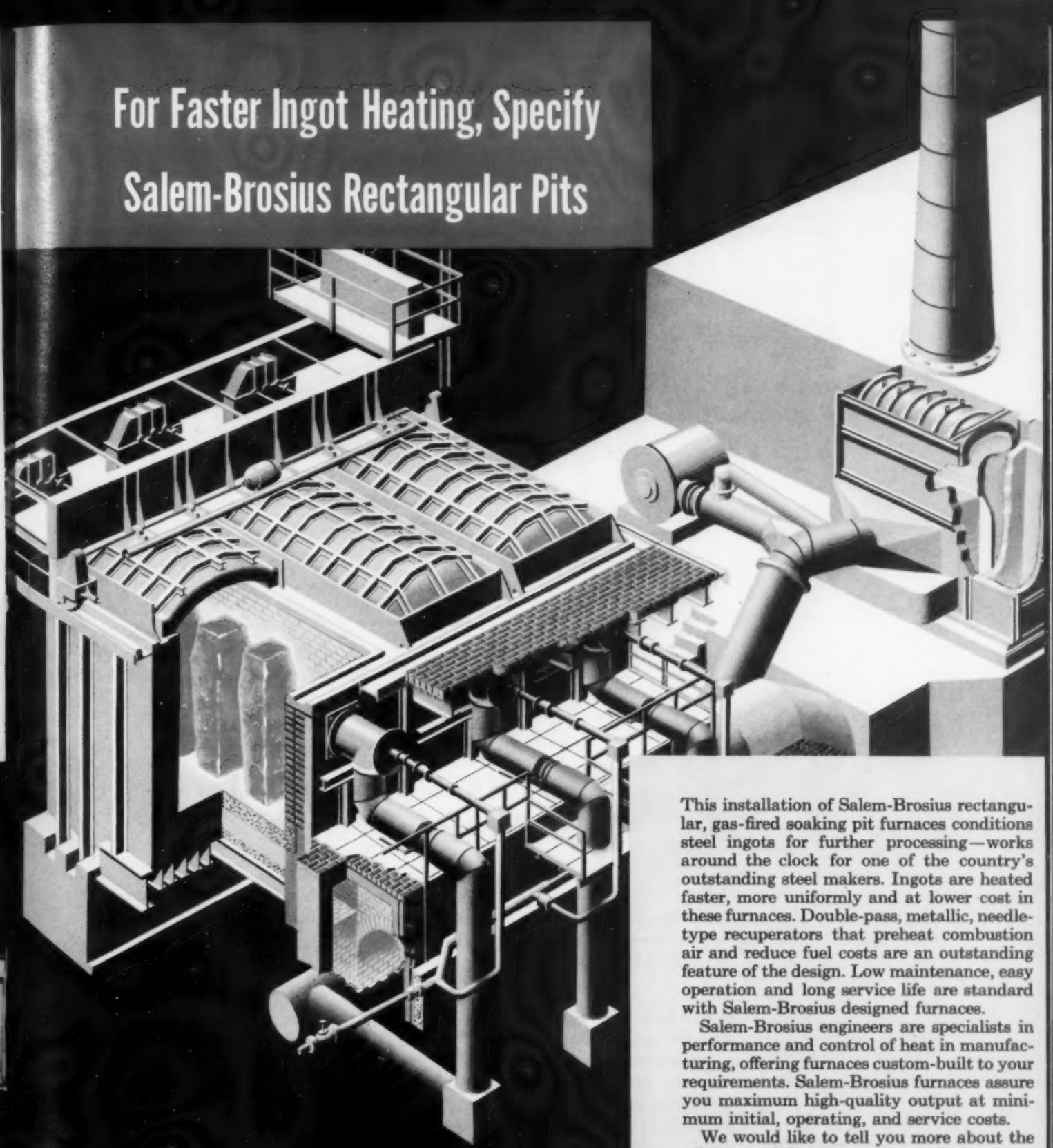
heavy duty lathes • steel and special alloy castings

For Faster Ingot Heating, Specify Salem-Brosius Rectangular Pits



This installation of Salem-Brosius rectangular, gas-fired soaking pit furnaces conditions steel ingots for further processing—works around the clock for one of the country's outstanding steel makers. Ingots are heated faster, more uniformly and at lower cost in these furnaces. Double-pass, metallic, needle-type recuperators that preheat combustion air and reduce fuel costs are an outstanding feature of the design. Low maintenance, easy operation and long service life are standard with Salem-Brosius designed furnaces.

Salem-Brosius engineers are specialists in performance and control of heat in manufacturing, offering furnaces custom-built to your requirements. Salem-Brosius furnaces assure you maximum high-quality output at minimum initial, operating, and service costs.

We would like to tell you more about the efficiency of these new units, and also about the well-known Salem-Brosius circular soaking pits.

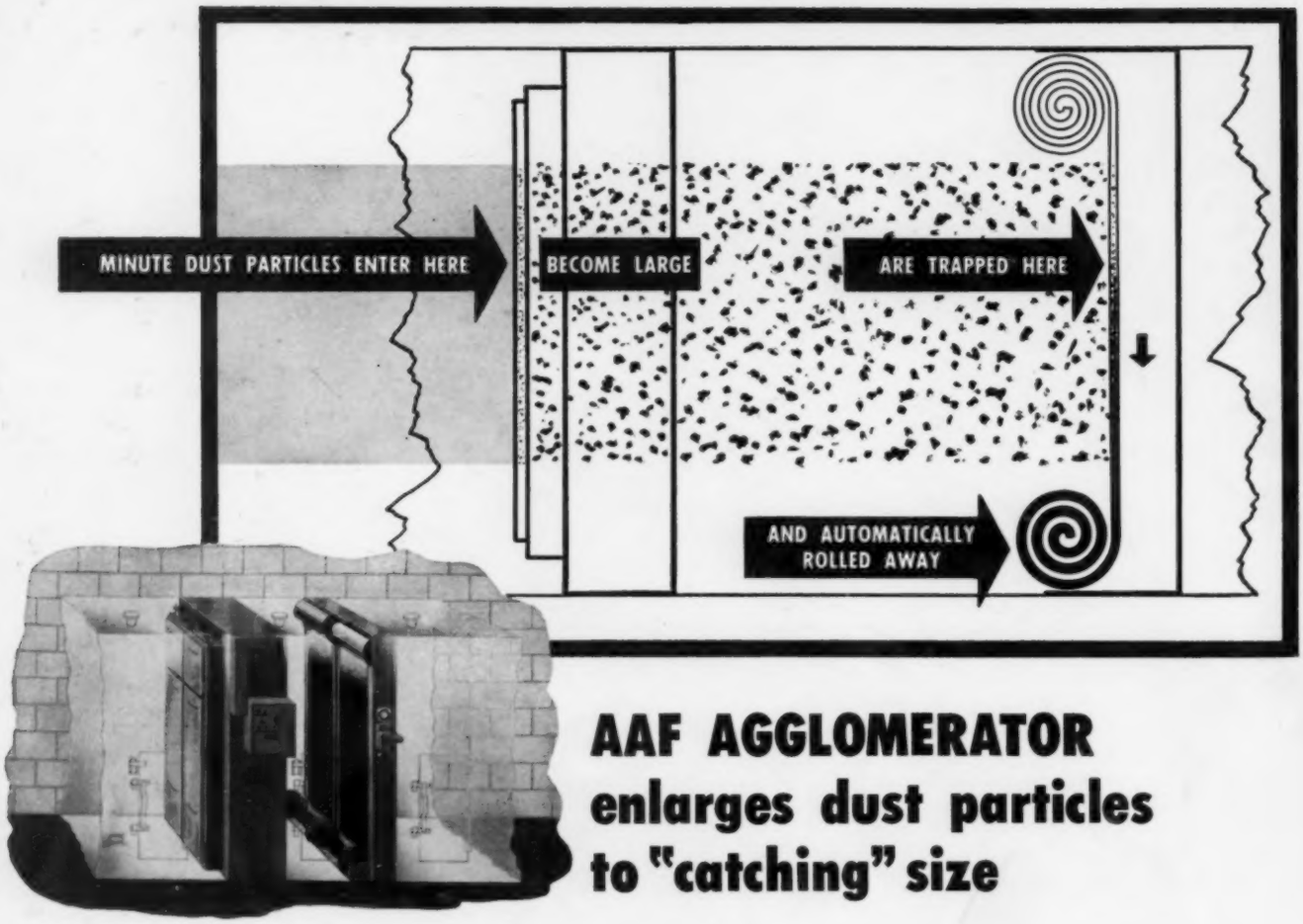
If your modernization or expansion plans call for heating or heat treating furnaces of any kind, write, wire, or phone Salem-Brosius.

SALEM-BROSIUS, INC.

CARNEGIE, PENNSYLVANIA

IN CANADA: SALEM ENGINEERING LTD. · 1525 BLOOR STREET WEST, TORONTO 9, ONTARIO

NEW AIR FILTRATION UNIT SLASHES MAINTENANCE COSTS



AAF AGGLOMERATOR enlarges dust particles to "catching" size

If excessive filter maintenance is preventing continuous and uninterrupted mill equipment service in your plant, you'll quickly see the low-maintenance benefits of AAF's new AGGLOMERATOR method of air filtration.

The AGGLOMERATOR is AAF's Electro-Cell electrostatic precipitator and the revolutionary Roll-O-Matic Filter in one common housing. Fine particles are attracted to the dry plates of the Electro-Cell and are held until they attach themselves to other particles. As these small particles combine to form large particles, air from the fan dislodges them and draws them through the unit and onto the automatically renewing media of the Roll-O-Matic.

Both filters offer completely automatic operation. There is practically *no maintenance* on the dry-plate Electro-Cell and maintenance on the Roll-O-Matic amounts merely to substituting a new roll of media when the old roll has become soiled.

For complete information on the maintenance-saving AGGLOMERATOR principle of air filtration, call your nearest American Air Filter representative or write direct.

AAF American Air Filter
COMPANY, INC.
302 Central Avenue, Louisville 8, Kentucky
American Air Filter of Canada, Ltd., Montreal, P. Q.

AAF Filters and Precipitators

AAF Dust Control Equipment

— BETTER AIR IS OUR BUSINESS —

Herman Nelson Unit Heaters

Illinois Heating Specialties

SEPT. 1956 VOL. 3 NO. 3

NATIONAL CARBON COMPANY'S

CARBON AND GRAPHITE NEWS

A COLD-CHARGE SHOP MOVES AHEAD

A COLD-CHARGE SHOP MOVES AHEAD

...with the electric arc furnace!

By R. S. Lynch, President
Atlantic Steel Company, Atlanta, Georgia

■Any growing company must periodically make basic decisions concerning expansions of capacity, weighing carefully all the factors involved to insure continued growth and profitable operation.

Atlantic Steel, an all open hearth shop for 50 years, has increased melting capacity several times during that period. Again faced with the need for major expansion in 1951, the logical question was – further increase of open hearth capacity or installation of electric arc furnaces?

Through the years, as the chart on the facing page indicates, we had taken one step after another to increase the ingot capacity and efficiency of our open hearth facilities. In the postwar period, it became evident that we were approaching the limit of such measures and that a new capital investment was necessary. The decision we made was to invest in electric arc furnaces.

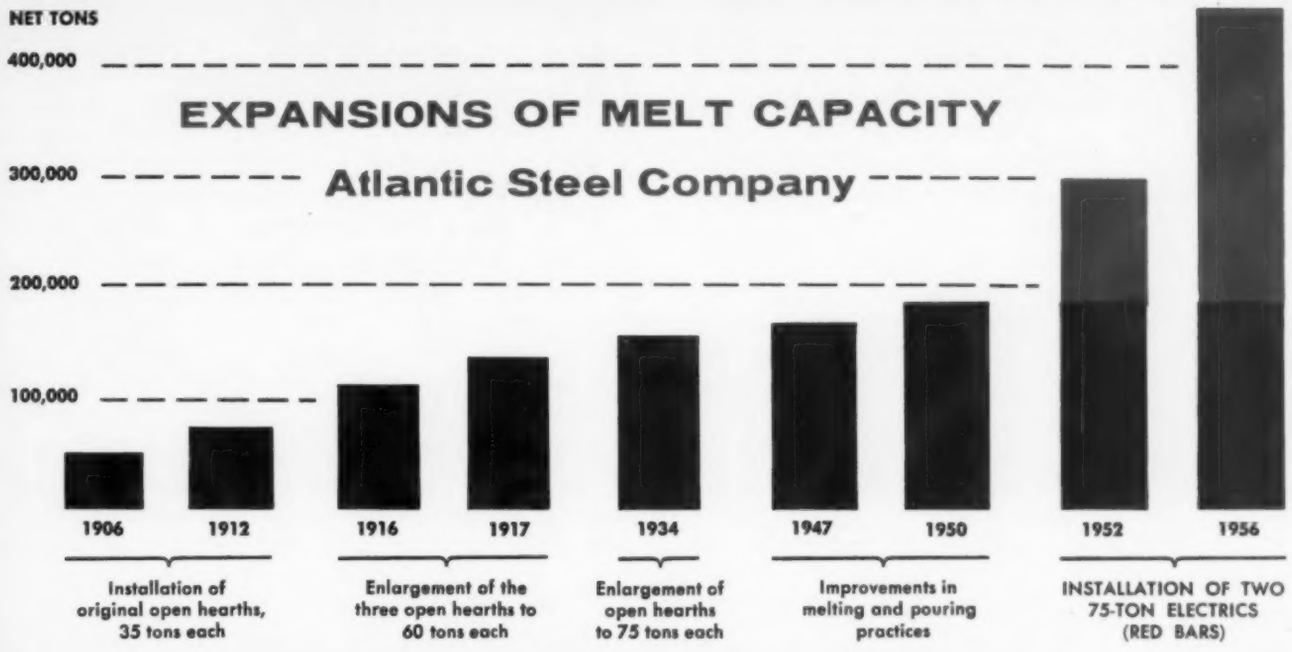
Several years of successful experience with our first 75-ton unit then dictated the installation of a second furnace.

Consequently, we now have acquired an ample basis for direct comparison of the electric against the open hearth on cold-melt, low carbon steel operations – making the same grades of steel, with the same personnel, and using the same raw material sources. The results of our experience show that our original decision was wise. The major advantages we have realized are:

LOWER FIRST COST. Our entire investment in the electric melt shop has been about 40% less than it would have cost to put in the equivalent open hearth capacity.

SAVINGS IN SPACE. Since our ground space is limited here in Atlanta, we appreciated the fact that the new melt shop, providing room for a total of three electric furnaces, takes up a third less space than would new open hearths producing the same tonnage.

FAST CONSTRUCTION. Each of our management decisions has been quickly transformed into new melting capacity. Because of the compactness, pre-fabrication and simplicity, an electric shop can usually be built more rapidly than an open-hearth shop of like capacity.



QUALITY CONTROL. Because our end-products require a wide range of carbon steel analyses, the electric furnace is particularly suited to our operation. Features important to us are precise temperature control and the absence of contamination from fuels.

FASTER HEATS. The four-hour heats of the electric furnace are a real boon to a custom shop such as ours. With adequate transformer capacity, we find that the only effective limitation on the heat input is the rate at which the scrap can absorb the heat.

FLEXIBLE OPERATIONS. We can produce electric steel according to demand – running the arc furnaces any number of shifts and any number of days per week. They start up quickly and shut down even more quickly, requiring the operator's attention only when producing steel.

LOWER OPERATING COSTS. Within six months after our first electric furnace was installed in 1952, it was producing steel at a lower net cost per ton than our open hearths which were working on the same grades. After the second furnace went into operation last fall, the economic advantage of the electric shop increased still more because of the reduction in its "cost above".

It should be emphasized that our shop produces no analyses outside of the low-carbon range – none of the high-priced alloy or stainless steels for which the electric furnace is usually required – yet we find that the arc has consistently reduced our costs and improved the efficiency of our operations.

We estimate that electric melting has reduced our ingot costs an average of 5%, compared to open hearth costs. Naturally, this figure varies somewhat with the cost of various raw materials. The cost advantage would also be different for other regions and end-products, but industry studies indicate that other non-integrated producers can also expect a substantial reduction of ingot costs with conversion to the electric furnace.

While on the cost factors, it is important to note that our power rates of 9-10 mills are neither high nor low as such rates go. Also, we have held our mold costs at about the same level as with the previous open hearth operation, by taking readings with immersion thermocouples to insure that electric furnace heats are not poured at excessive temperatures. And, we find that the electric furnace has reduced our costs for preparation of the scrap.

The flexibility and versatility of the electric shop are important operating factors to us because of the wide variety of our products. Since our founding, in 1901, to make cotton bale ties and turpentine barrel hoops, the list of products sold

under our trade-mark of "Dixisteel" has been steadily widened to include a complete line of merchant bars, reinforcing bars, fencing, nails, wire, small shapes and many other items. Hence the unusually wide variety of steel analyses — ranging from 5 to 40 points of carbon — and the extreme emphasis on flexibility in the Atlantic melt shop.

Some details of our electric shop experience may be of interest. We made the complete change-over with our regular open-hearth crews, excepting only an electric furnace melter hired from outside the company. Our personnel soon became skilled on the new furnaces and the training problems were minor, considering the scope of the change.

A most dramatic feature, of course, is the melting speed. The average heat cycle in our electric shop is four hours, but a good many heats approach the shop record of 2 hours and 45 minutes from charge to tap. The best heat we ever achieved with the open hearth was 7 hours, and our average was 8 hours. The slow charging operations on these open hearths made a painful contrast with the speedy top charging of our electrics. Our average output with open hearths ran about 8.5 tons per hour, but our electrics are running at almost twice that tonnage.

Another feature of the arc furnace which we find quite important is the ability to switch from single slag to double slag methods at will.

Our experience is 95% availability with the electrics where it was 90% with the open hearths.

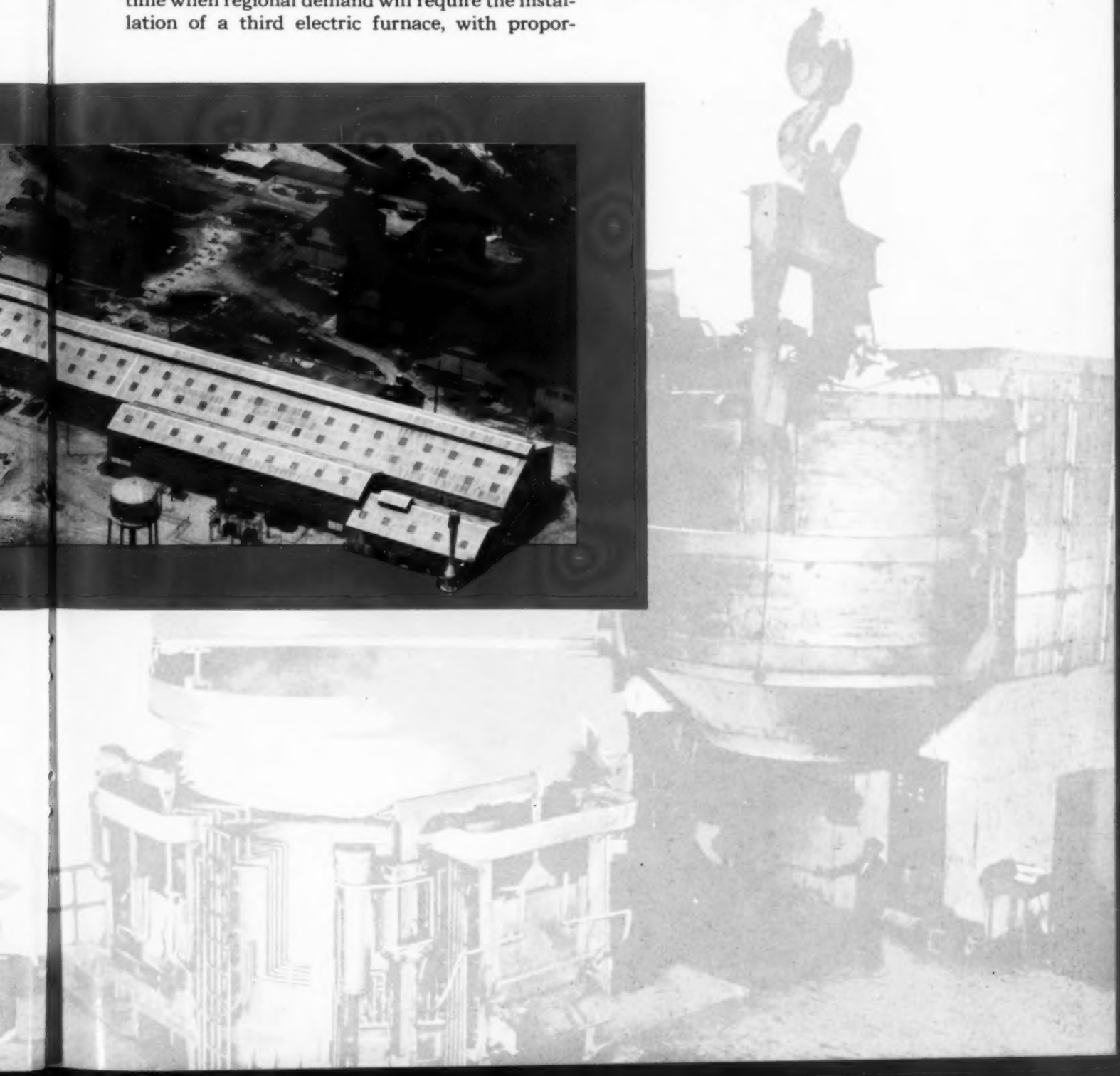
New $8½ million combination rod and bar mill — one of the world's fastest, with output of 5,000 feet of rods per minute and 40-50 tons of merchant bar products per hour — is part of Atlantic Steel Company expansion program.

Some reasons for the difference are obvious. A spare roof can be put in place in three hours. Complete relining, except for the furnace bottom, requires only 12 hours. As you might expect, our maintenance costs have been cut by more than 50%. Furthermore, it was our experience with open hearths that production began to drop off sharply toward the end of each furnace lining campaign, whereas the electric furnace maintains the high level of output throughout the life of a lining.

We see a great future for the electric arc melting of low-carbon "work-horse" grades of steel in bulk tonnages. And we look forward to the time when regional demand will require the installation of a third electric furnace, with proportionate expansion of other facilities.

Actually, such a time should not be so far away. We look forward to continued growth with plenty of competition to keep us on our toes and the electric melt shop to help us meet it on an equal basis.

To sum up the way we feel about our decision to install an electric melt shop, let me quote an experienced open hearth man who has gone through the entire change-over with us. J. E. Wilbanks, our Superintendent of Melting, says, "Electric furnaces can do everything that open-hearth furnaces can and do a better job of making quality steel at lower cost."



WHAT NATIONAL CARBON'S NEW SERVICE PROGRAM MEANS TO ONE ELECTRIC MELT SHOP

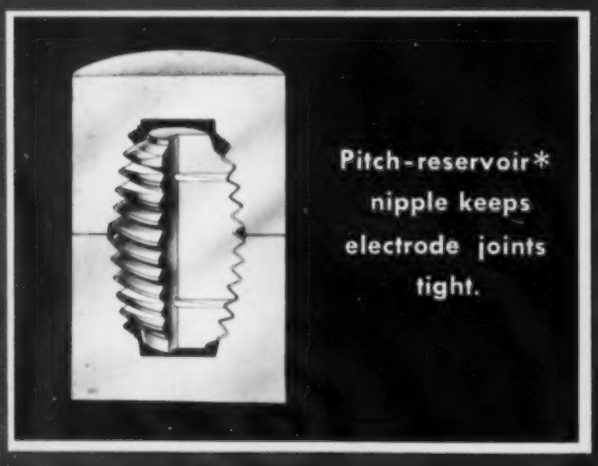
The TIMKEN Roller Bearing Company

■April's Carbon and Graphite News announced the latest revision of a long-time National Carbon technical service — a concentrated electrode service program to help operators obtain the best possible electrode efficiency. This program, extending the company's customer service policy, is capsuled in a presentation of approximately an hour's duration. First given in Pittsburgh last December before the Electric Furnace Conference of the A.I.M.E., 38 customer meetings have been held by the National Carbon Electrode Service Group with enthusiastic response. The program is paying off in improved electrode performance, lower costs and an altogether better operator understanding of electrode operation.

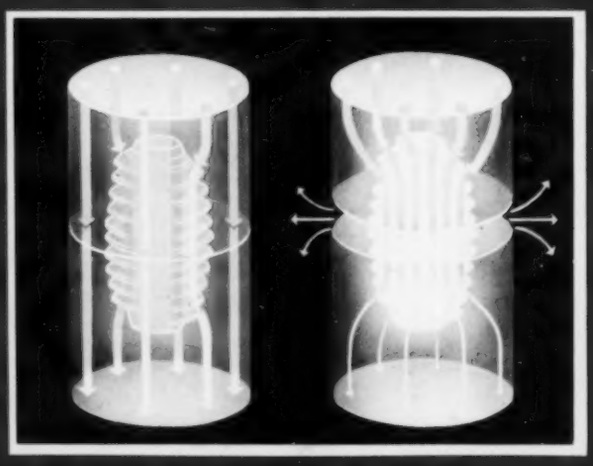
For this interview, your Carbon and Graphite News Reporter has visited Timken Roller Bearing Company to bring you an on-the-spot discussion with Melting Superintendent, H. F. Walther; Assistant Melting Superintendent, L. D. Petersen; General Foreman, R. C. Roth; and First Helper, M. Podoliak. We asked these gentlemen to comment on the National Carbon program which had just been presented to a typical Timken melt shop group.

Q. Gentlemen, obviously from the group's response here tonight, you people are very much interested in electrode operation. We all know that electrode costs are an important consideration in electric furnace operation — do you feel that our program will help you reduce these costs?

A. Let's put it this way. Electrode costs and elec-



*U.S. Patent No. 2735705



Good joining gives efficient current flow.

Open joint heats up nipple, causes breakage.

tric power costs are two major items in producing electric furnace steel which together account for about half of our "cost above".

We've been preaching this idea right along, so we were especially glad to hear your technical people emphasizing the do's and don'ts that make for best electrode performance at lowest cost. As a matter of fact, we'd say that if we could have reduced our electrode consumption as little as one half a pound per ton last year, we would have shown a cost reduction of approximately $80,000!

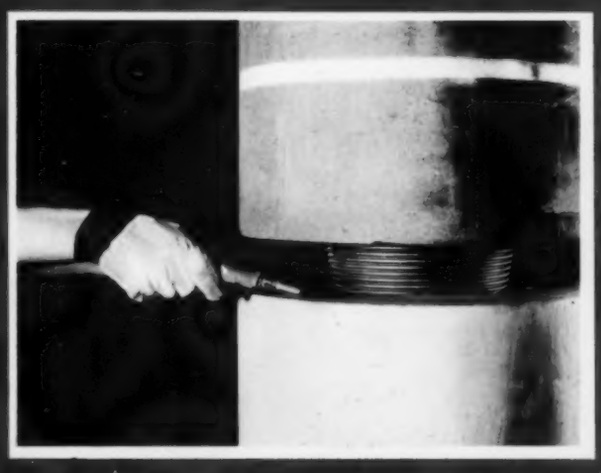
Q. That's an eye-opening observation – let's hope you'll be able to chalk up a cost reduction like this in the near future. Now, suppose you were to name one operational problem that stands out above all the rest, what would you pick?

A. There are several, of course. Electrode breakage resulting from falling scrap can be one of the most troublesome, perhaps. At The Timken Company, we strive to avoid this by correctly placing our scrap within the furnace. We have emphasized to our people how improper scrap placement can lead to scrap "caves", and how this falling scrap can strike electrodes hard enough to break them. We were glad to see the importance you attached to this in your color slides and talk. Calling attention to the problem graphically like that helps our operating people visualize even better the necessity for placing heavy scrap on the bottom of the furnace – medium to light scrap above.

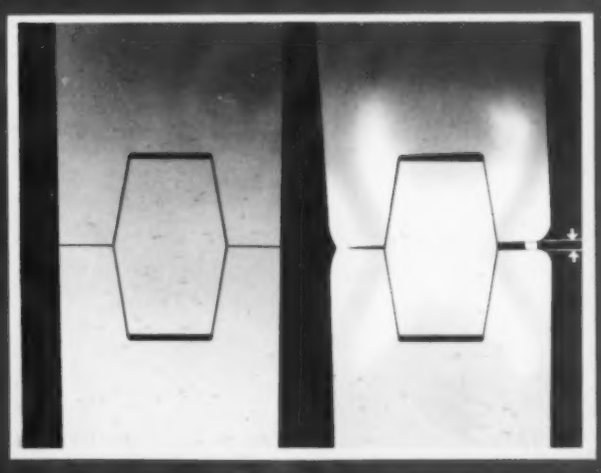
Q. A good portion of the time was spent here tonight discussing good joint-making procedure. Two points particularly seemed to stimulate a lot of interest: first, the importance of starting with a clean, chip-free end face and socket; and, second, the whys and wherefores of our recommendation that the connecting pin, or nipple, be added to the bottom of the old electrode rather than to the top of the new one. Would you like to comment on these points from your own experience?

A. Well, as to the matter of clean, chip-free end faces – it's easy to appreciate the desirability of maintaining maximum possible physical contact between the end faces of joined electrodes. Since ⅔ of the electric current goes through the end faces, we certainly want to avoid increased resistance at these interfaces. And, for the same reason, the sockets should be chip-free and clean so there will be no restriction between connecting pin and both sockets. It was good to hear you develop these thoughts further in your talk. Actually, that demonstrator unit of yours showed us more graphically than anything else we've ever seen just how seriously a lack of intimate electrical contact at the joint can affect electrode performance. It was easy for our men to associate the demonstrator's brightly glowing lamps with the unrestricted passage of current that results from a good, clean, tight joint. And, conversely, the dimly glowing lamps readily got across the idea of the poor passage of electrical current which occurs when joints are improperly made. You people must be receiving considerable comment from the field on this novel demonstrator unit.

Q. Yes, that's right—we're getting a lot of evidence that it's helping promote a better understanding



Use air hose for easy, sure removal of chips



What happens when chips remain on the face

of just what does take place at the electrode joint. And, it also helps operators understand some of the reasons for our recommended electrode handling practices. Perhaps there was some development touched on tonight that impressed you particularly – something you'd like to comment on?

A. One especially – we think one of the most significant developments in the electrode field in many years is your new pitch reservoir nipple. It has enabled such an improvement in joint-making practice that electrode and nipple breakage from unwinding has just about been eliminated in our shop. This has reduced electrode consumption.

You know, here at The Timken Company we were one of the first shops to recognize the potentialities of this new pin – and, we were one of the first to adopt it. Your cut-a-way color slide tonight showed our men exactly how the pitch in this new pin cokes under heat to lock the electrode joint firmly together. This was particularly well illustrated, we thought.

Q. Well, gentlemen – we certainly have appreciated the chance to meet with you here at Canton tonight and exchange ideas. As a parting shot, if you had to pinpoint the most valuable aspect of these meetings, what would it be – where would you say they're most helpful?

A. We think it's been a big help in two ways. First, your vivid presentation of the basic factors underlying our electrode costs has highlighted the problems our furnace crews face everyday. Second, there's no doubt, after the free give-and-take discussion here, that our men will put a lot of these basic ideas into practice, resulting in a long-term benefit to our company. In fact, we expect this will stimulate many more discussions of our own. Thanks for coming.

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A Division of Union Carbide and Carbon Corporation
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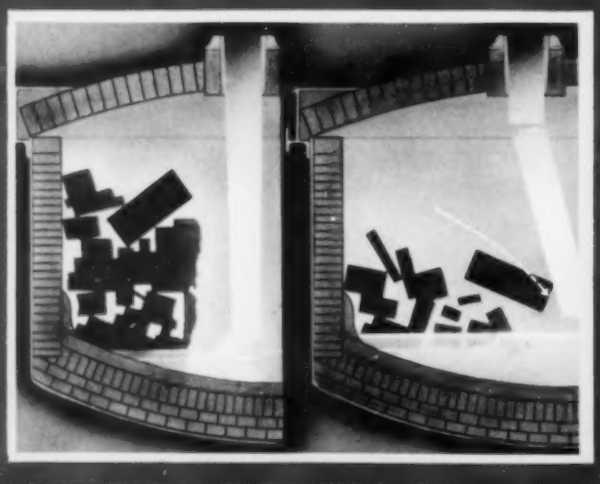
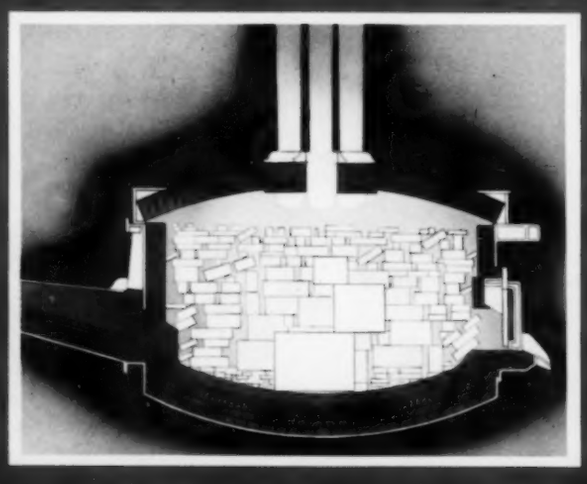


Effect of improper placement of the scrap

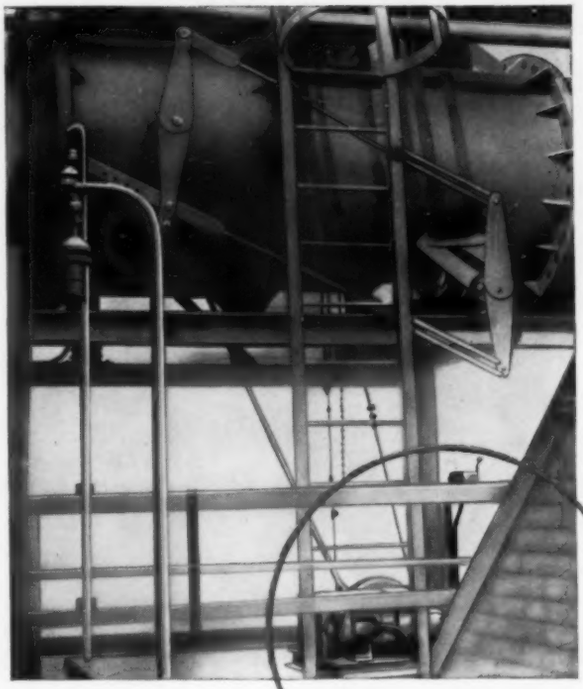


Proper positioning, heaviest scrap at bottom

Freyn-Design MOTOR OPERATOR

For Any Blast Furnace Snort Valve

...Fast, Positive Power Operation!



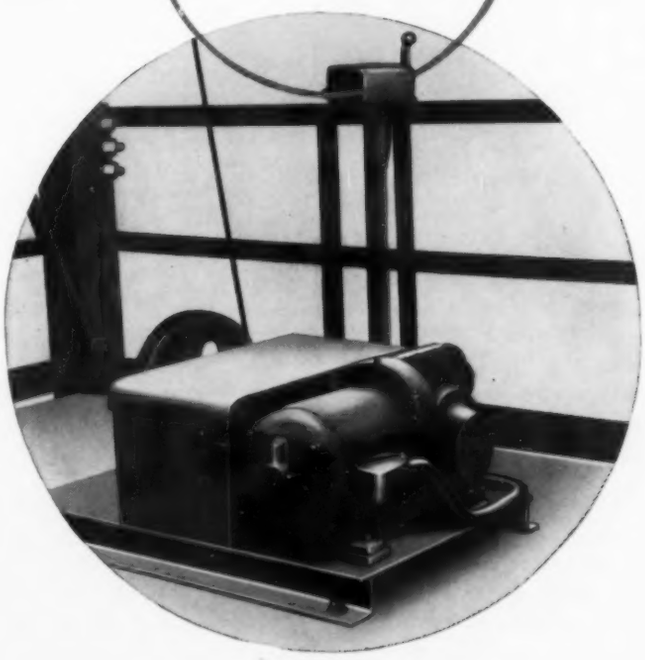
Located right at the snort valve, the Freyn-Design Motor Operator provides a direct mechanical drive between the snort valve operating shaft and the motor operator drive shaft. It is thereby not dependent on long cables extending from the cast floor handwheel.

A master switch for controlling the operator is located in the cast house. Additional switches can be easily installed, giving you the advantage of controlling the operator not only from the cast house, but also from *any* location desired.

In the event of electrical power failure, the motor drive automatically disconnects, permitting full use of the handwheel which is provided in the cast house for emergency manual operation.

There are seven installations of this type of Freyn equipment at three blast furnace plants—*and four of these installations were repeat orders!*

Write for booklet giving drawings and descriptive information, or consult with our engineers.



Top Photo: The snort valve at top responds quickly, is easier to control with the Freyn-Design Motor Operator shown at bottom.

Bottom Photo: Close-up of motor operator with one of several master switches (on top rail) in addition to the master switch in the cast house.

REPEAT ORDERS BASED ON PERFORMANCE

KOPPERS

KOPPERS COMPANY, INC.

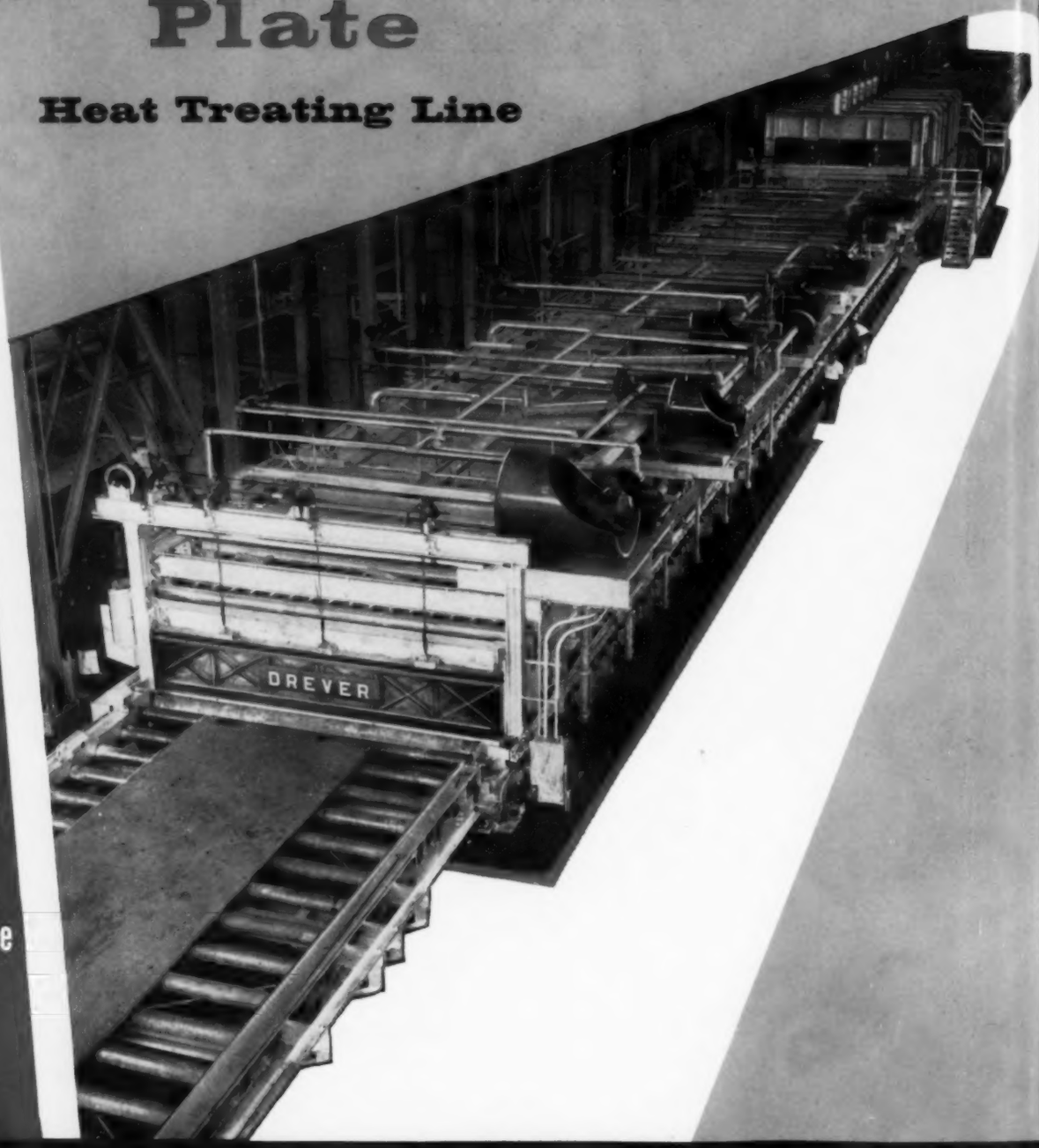
Freyn Department

Engineering & Construction Division

KOPPERS BUILDING · PITTSBURGH 19 · Associated with Ashmore, Benson Pease & Co. Ltd., Stockton-on-Tees, ENGLAND De Lattre & Freyerf, Paris, FRANCE

DREVER Plate

Heat Treating Line



Shown is the charging end of a 145′-0″ hardening furnace. In the background can be seen a 2500 ton pressure quench, 200′-0″ draw furnace and the operator's control pulpit.

This roller-hearth plate heat treating line, known to be the largest of its type, has a capacity to treat plate up to 21-1/2 tons per hour. The equipment is capable of handling plate sizes up to 172″ wide x 3″ thick x 600″ long.

The furnace rolls are 25/12 modified alloy and are designed for a maximum furnace operating temperature of 1650° F.

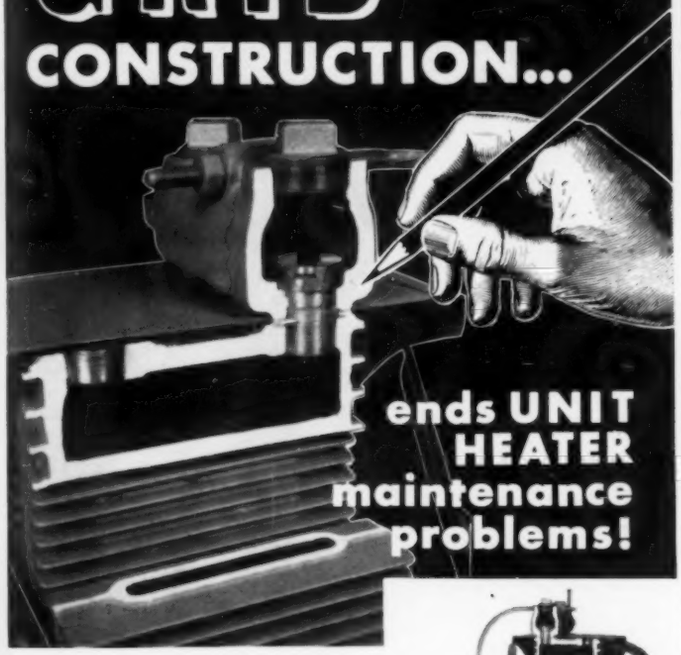
The maximum fuel capacity for both furnaces is 122,000,000 Btu's per hour.

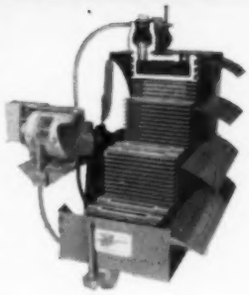
The entire line is under the control of a single operator. Full utilization of strategically located TV cameras enables the operator to have full control over all operations.

DREVER COMPANY

RED LION ROAD and PHILMONT AVE., BETHAYRES, PA

GRID CAST IRON CONSTRUCTION...



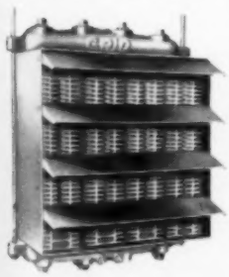


Corrosion in unit heaters — external, from contaminated air . . . internal, from electrolytic action *ENDS* — when your unit heaters are GRID cast iron construction, here's why — GRID heating sections are made of high-test cast iron . . . no external corrosion from acid or other fumes present in many plants.

All metals in contact with steam are similar . . . no electrolytic action internally . . . no internal corrosion.

GRID construction ends your unit heater maintenance problems — because GRID will operate on steam pressures up to 250 P.S.I. . . . 450° temperature . . . no pressure-reducing valves needed. No soldered, brazed, welded or expanded connections . . . a specially designed threaded nipple provides a leak proof joint (see illustration).

GRID design gives you maximum heating performance because — GRID provides more air changes at lower outlet temperatures . . . carefully selected motor speeds and fan capacities positively deliver warm, comfortable air in ample volume to floor level . . . no wasted heat through stratification.



GRID installations save you money as GRID requires no maintenance . . . is practically self-cleaning (note wide fin spacing in illustration). GRID provides long service life . . . units installed in 1929 are still operating. No ordinary unit heater approaches GRID's record for continuous trouble-free heating service.

Get the complete story on GRID Unit Heaters, GRID Blast Heaters and GRID Radiation for steel mill and blast furnace use. Write for your copy today.

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Manufacturers Since 1883

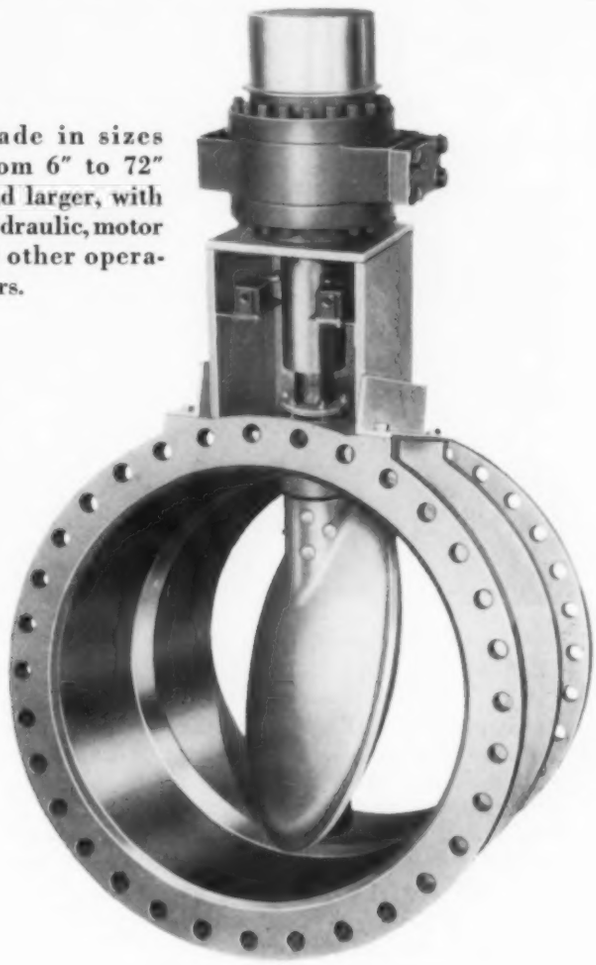
WAUSAU, WISCONSIN

Stress-Sealed Butterfly Valves

for "Tight" Closure to 200 psi and 1500°F.

The valve disc has a stainless steel edge which seats against an Inconel band in the valve body. The band is inflated for tight shut-off. Offset shaft design permits full 360 degree sealing surface of disc against hot air, gas or liquid pressure.

Made in sizes from 6" to 72" and larger, with hydraulic, motor or other operators.



W. S. Rockwell valves are made in many types and materials of construction for handling air and gases, from sub-zero to 1600° F., cooling water, process fluids and granular solids. These are available in butterfly, slide, gate, swing gate, check and other types. Write for catalog.

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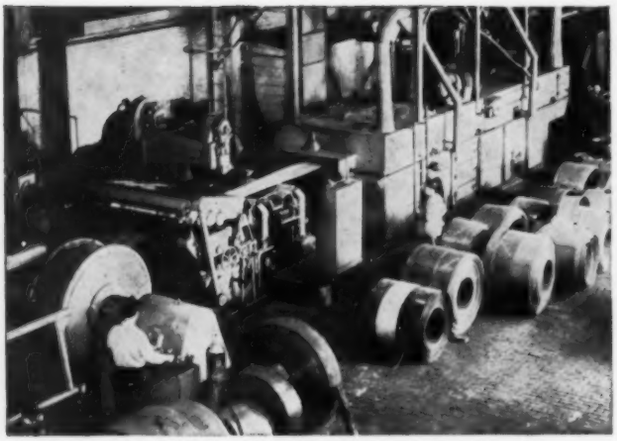
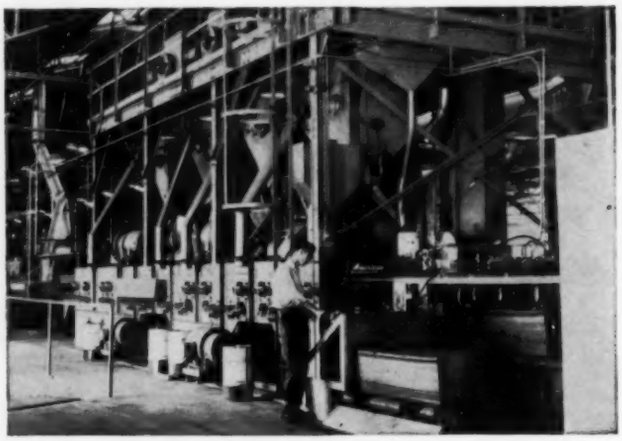
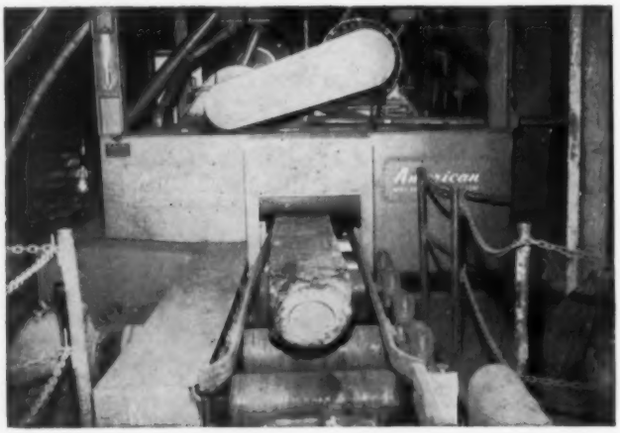
WHEELABRATOR® CLEANING SAVES MONEY EVERY TIME



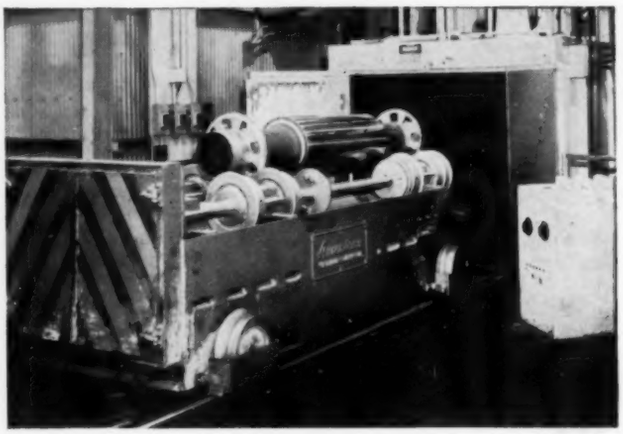
Descaling Strip at Allegheny Ludlum Steel Corp.



Descaling Sheet at Rheem Manufacturing Co.



Descaling Slabs, Billets at Atlas Steel, Ltd.



Etching Mill Rolls at U.S. Steel's Fairless Works

Mechanical descaling with the airless Wheelabrator as an integral unit in steel cleaning lines offers impressive savings in lower production costs for steel producers and fabricators alike.

In descaling steel sheet or strip or etching mill rolls, Wheelabrator's controlled abrasive blast cuts costs in many ways: reduces or eliminates acid pickling; slashes labor costs, crane service and space requirements; improves product quality; adds to equipment life.

More than 60 Wheelabrator installations now descale slabs and billets, continuous carbon strip, sheet steel, bar stock, wire rod and structural steel shapes. They also condition ingot molds and etch mill rolls.

These achievements demonstrate Wheelabrator's leadership and ten years' experience in this field.

Write today for complete information on a Wheelabrator machine for your descaling requirements. Ask, too, for a test demonstration on your own products in our fully equipped laboratory or ask for the name of a plant where you can see the Wheelabrator in operation.

Write today for this fact-packed Bulletin, No. 864.

WHEELABRATOR
CORPORATION

WHEELABRATOR CORPORATION, 396 South Byrkit Street, Mishawaka, Indiana

NEW!

CLARK AISE-NEMA BRAKE

Bulletin 106, Type "B"

with many exclusive features for

- **MORE DEPENDABLE OPERATION**
- **EASIER MAINTENANCE**
- **GREATER SAFETY**

This new line of CLARK Bulletin 106, Type "B" heavy-duty DC brakes conforms completely to AISE-NEMA standards. Economies in overall size are achieved without sacrificing ruggedness or dependable operation. The new design retains the famous "nut-cracker" principle of former Clark brakes, which assures equal distribution of applied pressure. And it incorporates many entirely new features for greater safety and easier maintenance.

The first of these new brakes to be available is the 13-inch wheel size illustrated. Other sizes to follow.

features...

- Equal distribution of shoe pressure against wheel
- New simpler and easier method of replacing shoes
- All maintenance adjustments made from the top
- Single adjustment for air-gap. Built-in indicator
- Magnet can be removed and replaced without disturbing brake adjustment or releasing the brake
- Coil replacement easily accomplished on the job
- Wheel and motor armature removable as a unit without disturbing brake adjustment
- Cast steel construction—cast aluminum shoes

—and many others

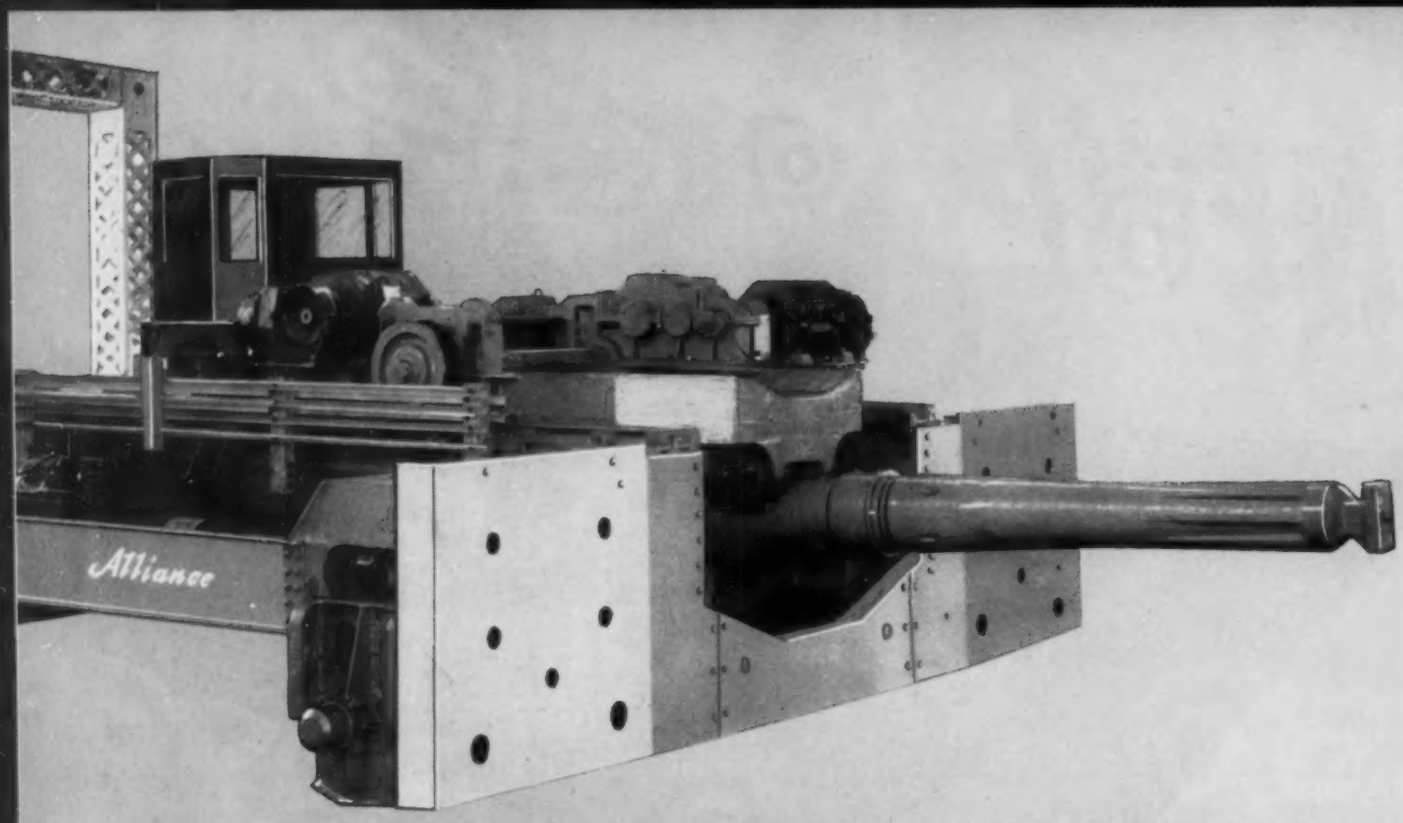
See this brake demonstrated at the Iron and Steel Show, Booths 89, 90, 111 and 112.

The **CLARK CONTROLLER** *Company*

Engineered Electrical Control

1146 East 152nd Street • • Cleveland 10, Ohio

IN CANADA: CANADIAN CONTROLLERS, LIMITED • MAIN OFFICES AND PLANT, TORONTO



This Charging Machine was built by The Alliance Machine Company, Alliance, Ohio . . . leaders in the heavy material handling equipment field for over 50 years. Contact Alliance for your requirements.

LADLE CRANES

GANTRY CRANES

FORGING MANIPULATORS

SOAKING PIT CRANES

STRIPPER CRANES

SLAB AND BILLET CHARGING MACHINES

OPEN HEARTH CHARGING MACHINES

SPECIAL MILL MACHINERY

STRUCTURAL FABRICATION

COKE PUSHERS

•

New 12-TON CHARGING MACHINE

• **The NEW Alliance 12-ton,** low-type open hearth Charging Machine has spring-loaded pitman so, if the charging box pushes up over scrap in the furnace, the trolley's front wheels remain on the rails. Trolley always has sufficient traction to retract peel and box from furnace.

• **Each bridge girder** of Alliance's NEW Charging Machines consists of two wide-flanged I-beams welded to form a box section. Between webs of this box section, diaphragms are welded at 3-ft. intervals. This, plus other welded reinforcements, keeps charging machine square and rigid.

• **Machinery deck plate,** extending full length of bridge between main girder and outrigger girder, laterally reinforces the main girder and helps keep charging machine square and stable under all operating conditions.

• **Stabilized, shock-absorbing wheels** operate at rear end of trolley. Two rear wheels engage upper rail; two adjacent wheels engage lower rail. Powerful springs hold wheels in contact with rails at all times. This spring suspension absorbs and disperses engaging and disengaging shock at end of the peel, reducing operator shock and fatigue to a minimum.

• **On eight-wheel bridges,** the four trucks located at corners of the bridge are equalized to compensate for any track irregularities.

• **New hydraulic lock rod** gives operator finger-tip control and eliminates laborious work incident to the hand-operated lock rod. All gears (including track wheel gears) are fully enclosed and run in oil.

WORLD'S LARGEST BUILDERS OF WORLD'S LARGEST CRANES

Founded 1901

THE *Alliance* MACHINE COMPANY

MAIN OFFICE • ALLIANCE, OHIO

GIVE US THE RUNWAY AND WE'LL LIFT THE WORLD

Equipment News...

ANNEALING FURNACE

▲ A new continuous bright annealing furnace capable of maintaining a high quality finish on welded stainless steel tubing from ¼ in. O.D. to 4 in. O.D. has been installed at the Steel & Tubes Division of Republic Steel Corp.

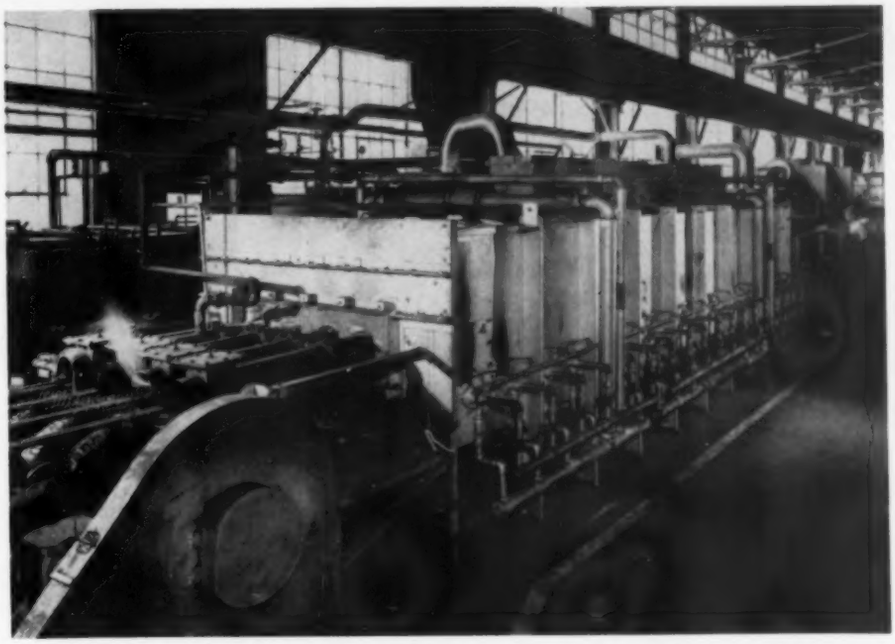
It retains the surface qualities of the original flat-rolled steel finish on welded stainless tubing without the subsequent need for polishing for many applications. As a result, it can eliminate the high cost of polishing borne by the tube purchaser. At the same time, it reduces ordinarily required pickling operations. The resulting pickling is for cleaning purposes rather than for scale removal as required in ordinary furnaces.

One of the most important quality advantages of this process is the assurance of a scale-free inside diameter, especially on long length small diameter tubes which are difficult to pickle clean when annealed in a furnace that allows a scale to form.

The unit has a rated capacity of 1,000 lb per hour at a maximum temperature of 2100 F. The furnace proper consists of four high temperature alloy steel muffle tubes extending through a gas-fired furnace and connecting with tubular, water-cooled chambers. Alloy wire mesh chain belts extending through these carry the work through heating and cooling chambers which cover an area 78 ft long.

It has power-driven feed and discharge conveyors, for handling the work to and from the furnace. The conveyors, along with the mesh belts carrying the work through the furnace, have adjustable speeds which permit variation of the traverse speed to suit the work being processed. These speeds vary from one to six ft a minute.

Use of the furnace has resulted in following operational advantages, according to Republic: Improved surface finish resulting from the elimination of heavy scaling produced by open type furnace; Reduced maintenance and deterioration of building and pickling equipment due to the elimination of hydrofluoric acid; Reduction of difficult and expensive acid disposal problem; Greatly reduces the safety hazards encountered in use of nitric hydrofluoric acid baths; Reduces handling and transportation required by previous method.



Installed in the Steel & Tubes Division of Republic Steel Corp., this continuous bright annealing furnace produces a high quality finish without polishing for many applications. As a result, it can eliminate the high cost of polishing borne by the tube purchaser; it also does away with much of the ordinarily required pickling operations.

SPECTROMETER

▲ Development of a new vacuum direct-reading spectrometer for the rapid analysis of five principal elements in steel has been announced by Applied Research Laboratories.

The new instrument, called the "Quantovac," permits the rapid spectrochemical analysis of carbon, phosphorus, sulfur, silicon and manganese from the sparking of a single sample. The time required for a duplicate analysis is two minutes. The analysis of all five elements are recorded in ink on paper to form a permanent record.

A vacuum attained with a mechanical pump is sufficient for the spectrometer. Tank nitrogen is used around the sample in the excitation stand. The spectrum region normally used is 1500° A to 3500° A. However the instrument can be readjusted to cover the region from 1100° A to 3500° A to permit research in the analysis of the gases—hydrogen, nitrogen and oxygen—in metals.

BATTERY COATING

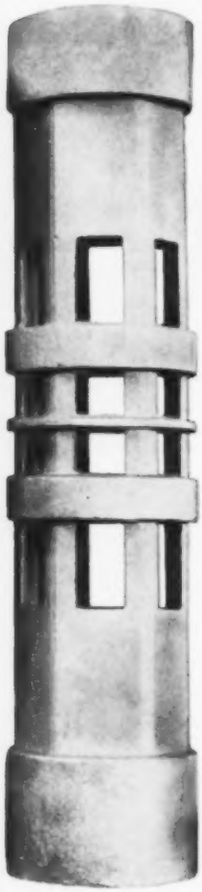
▲ Developed by Exide Industrial Division of the Electric Storage Battery Co. is a new air-drying, protective finish for steel battery trays which eliminates the baking process in manufacture.

The quick-drying finish—called "Flexide"—not only has excellent adhesion and electrical insulating properties but is highly resistant to abrasion and acid. It can be used by manufacturers to speed tray production and by truck users to make on-the-spot repairs without time lost in baking.

Exide is believed to be the first manufacturer of motive power batteries to use a finish of this type on its complete line of industrial truck battery trays, including the company's new hand truck trays which conform to dimensions and practices of Industrial Truck Association.

DURALOY

HIGH ALLOY CASTINGS *to your order*



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SMALL
SPECIAL SHAPES
CORROSION RESISTANT
HEAT RESISTANT
ABRASION RESISTANT

Duraloy is the BEST place to come for your high alloy casting requirements. We are specialists in turning out castings to order. Simple jobs, tough jobs; large jobs, small jobs. Static cast or centrifugally cast . . . you name it and we'll produce it.

The melt, the casting and the finishing are all carefully controlled and quality tested by our technicians. Our test equipment, including 400,000 volt X-ray and gamma ray facilities, is just one way Duraloy assures delivery of Better High Alloy Castings.

Send for Bulletin No. 3354-G.

THE DURALOY COMPANY
OFFICE AND PLANT: Scottdale, Pa.
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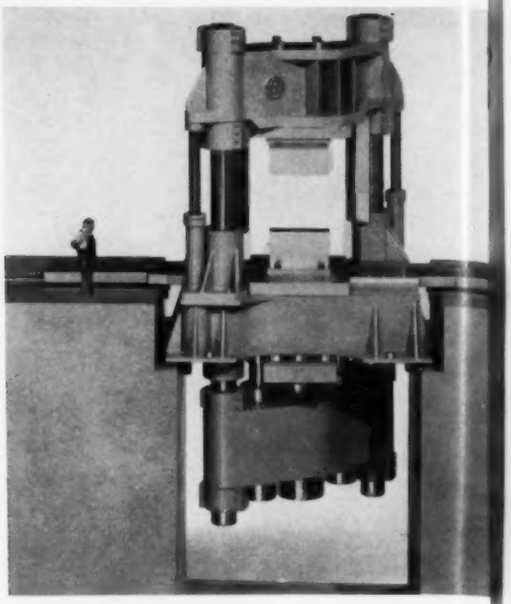
DETROIT OFFICE: 23906 Woodward Avenue, Pleasant Ridge, Mich.
CHICAGO OFFICE: 332 South Michigan Avenue



FORGING PRESS

This is the preliminary model of a 2000-ton self-contained hydraulic forging press designed and manufactured by Lake Erie Engineering Corp. for Allegheny Ludlum Steel Corp., Dunkirk, N. Y. The single-action press is of a pull-down, 2-column design and operates at 60 planishing strokes or 30 forging strokes per minute. The bed of the press is equipped with a movable die slide which is powered by a hydraulically-operated gear and rack arrangement. Controls for the press are mounted on a stainless steel console adjacent to the press. 19½ ft of the press are above the floor, while 15 ft are below.

"Flexide" is compounded of a plastic base material with fillers to produce the desired color and physical and chemical characteristics.

Impervious to battery acid, the finish provides a continuous, impermeable coating with no pinholes or edge-thinning. It permits a thicker coating and provides more protection per application than was possible with baked-on finishes. Accordingly, Exide has standardized on a thicker coating than formerly used on electric industrial truck battery trays.

The new finish is superior to an equal thickness of baked finishes both in abrasion resistance and electrical insulation. It has outstanding abilities to cover and spread smoothly and easily over a tray surface; to adhere to steel in impact and abrasion tests; to withstand battery acid and limit tray corrosion; and to provide electrical insulation.

Easily applied with brush or spray gun, "Flexide" makes it possible for the battery user to quickly and eco-

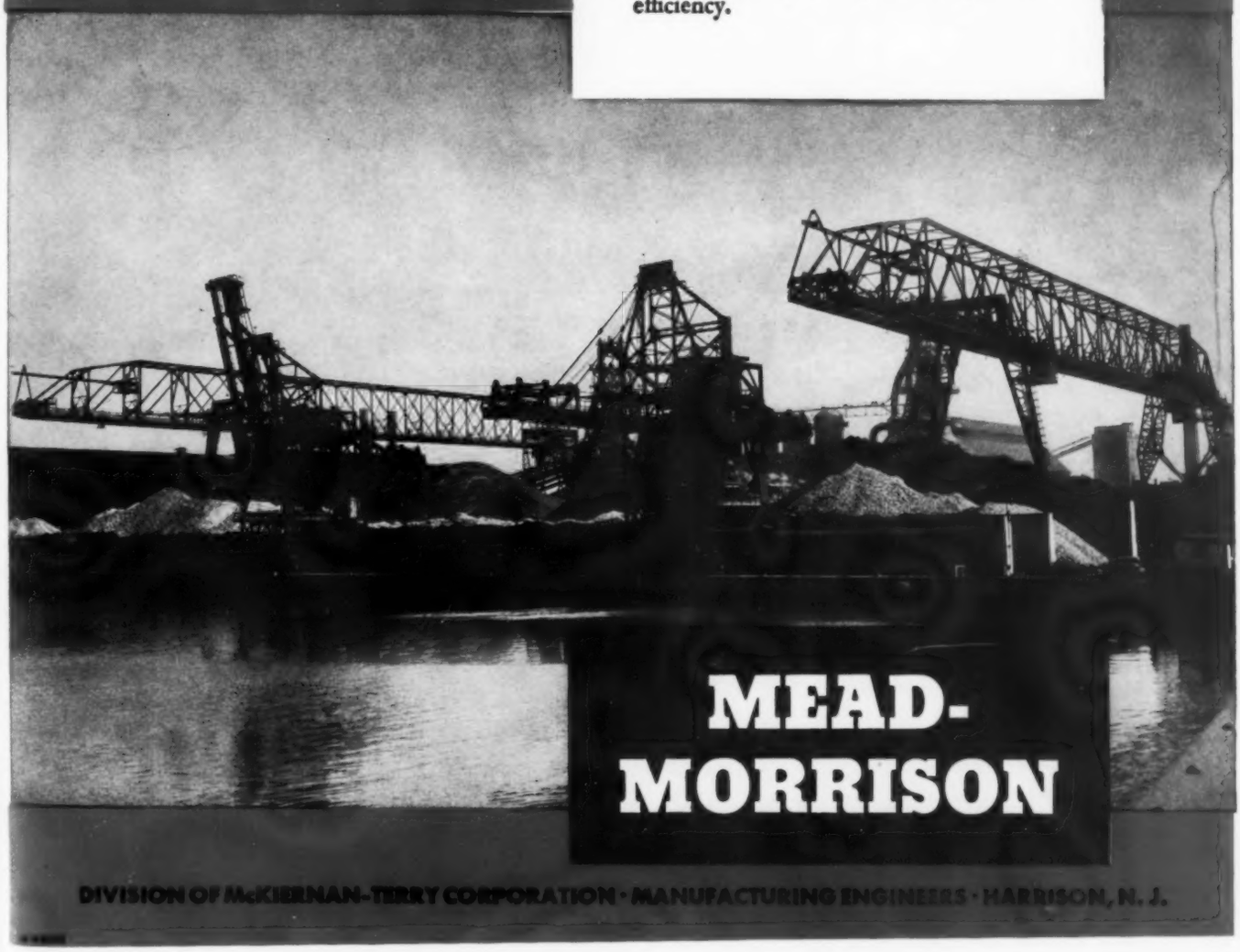
all set for speedy material handling

This team of two Unloaders and two Bridges are part of the Mead-Morrison material-handling equipment at the Indiana Harbor Works of Inland Steel Company.

Each of the structures and their equipment has a capacity of 12 tons and is of the man-trolley type. The unloaders discharge ore or limestone from lake steamers, and deposit it in the trough, from which it is rehandled by the bridges to storage piles and to the high line feeding the blast furnaces.

Additional Mead-Morrison Bridges and Unloaders are also operating in the coal storage yard of this same steel company.

If you need new unloading facilities or increased capacity from your present equipment, the Mead-Morrison engineers will help you plan for greatest efficiency.



MEAD-MORRISON

DIVISION OF McKIERNAN-TERRY CORPORATION · MANUFACTURING ENGINEERS · HARRISON, N. J.

nomically repair scratched or damaged surfaces, and thus, to provide continuous tray protection.

ITV TUBE

▲ Diamond Power Specialty Corp. announces availability of a new television camera tube, the Diamond Utilicon 600.

The tube has extremely high sensitivity several times greater than other tubes of its type. Surface characteristics are such as to provide more uniform background shading and black to white contrast. Resolution capability is 600 lines. Side tubulation has been eliminated thus permitting rotation to obtain maximum horizontal resolution. Utilicon 600 is readily interchangable with tubes used in customary industrial television cameras.

THREAD FITTING

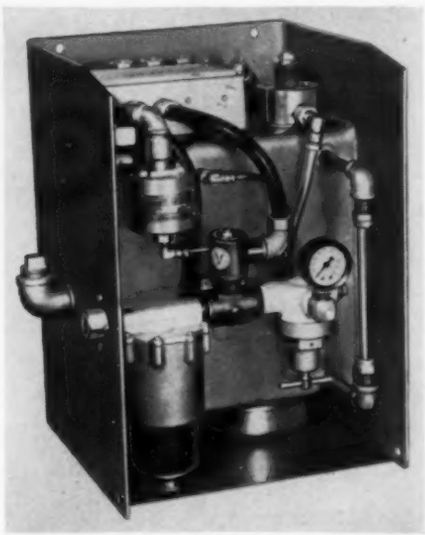
▲ The Parker Appliance Co. has introduced the "FG5-S" adapter, a fitting to facilitate changeover from pipe threads to straight threads in various applications such as valves or other units that are too large to be removed to a bench for re-machining of the ports.

In the nomenclature, the "F" signifies a male pipe threaded end, the "G5" indicates the internal straight thread o-ring boss on the other end, and the "-S" denotes steel as the material. After the pipe threaded end is screwed into the valve port, it is welded for a permanent joint, leaving the other end of the adapter providing the new straight thread mounting boss.

LUBRICATORS

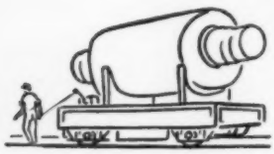
▲ Two new Alemite Oil-Mist lubricators designed to provide a "48-hour week" of continuous lubrication for up to 300 or 500 bearing in. of lubricated mechanisms while consuming but $\frac{1}{10}$th as much oil as by any other method of lubrication have been announced by the Alemite Division of Stewart-Warner Corp.

The newest lubricators operate efficiently whether in a compact installation or extended over a distance of 400 ft—with automatic control of all operating conditions. Built-in safety switches respond instantly for maximum machine life.

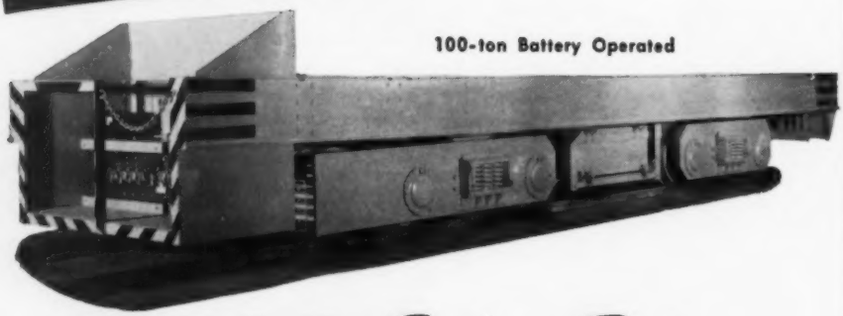


Alemite's Oil-Mist systems of lubrication use compressed air to atomize oil into mist (oil particles lighter than air) which is then distributed through tubing to all types of mechanisms requiring lubrication such as anti-friction bearings, plain bearings, gears, slides, ways, chains, cams and rollers. The system is operated automatically from the machine's "on-off" switch, has no moving parts

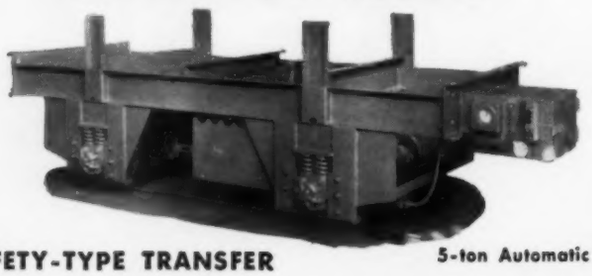
HANDLES THE BIG LOADS WITH BIG SAVINGS



100-ton Battery Operated



ATLAS *Safety Type* TRANSFERS



5-ton Automatic Controlled

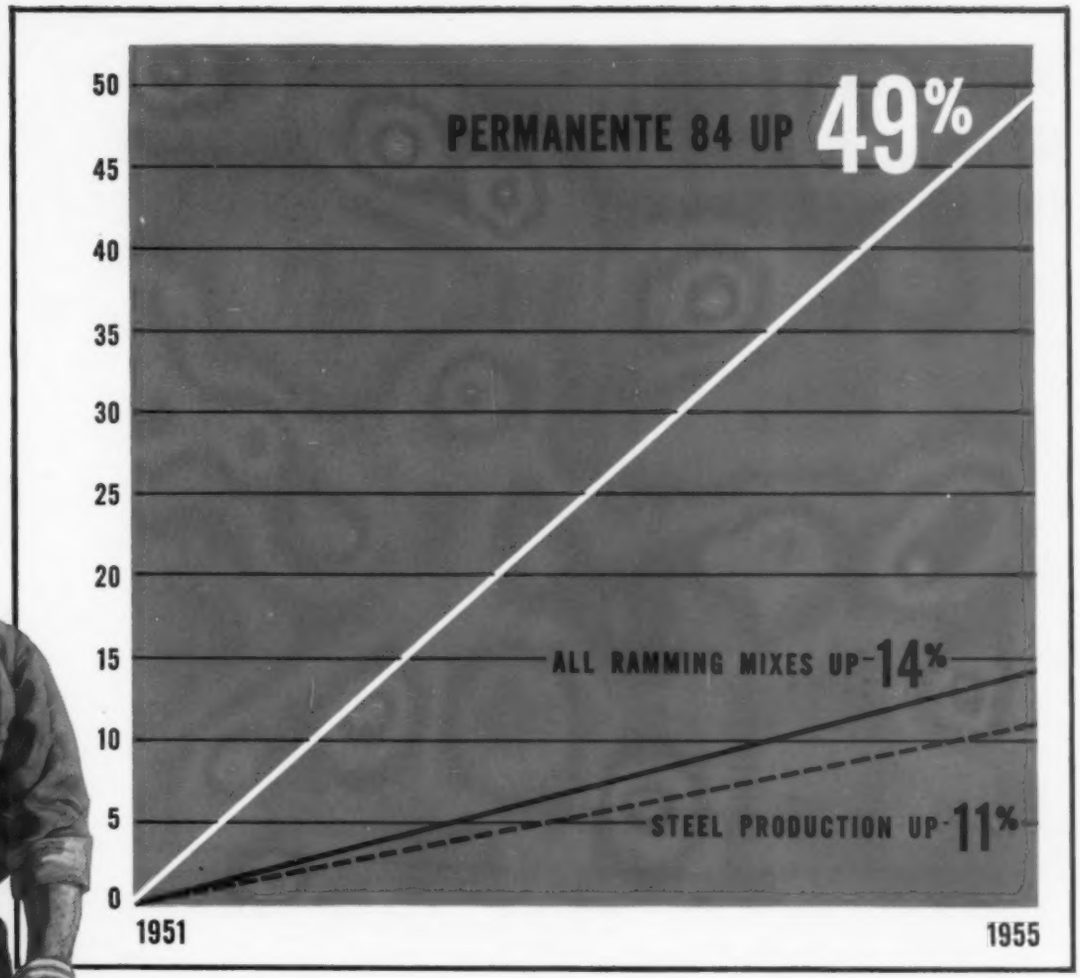
ATLAS SAFETY-TYPE TRANSFER CARS can be provided in almost any capacity for storage battery, diesel or gas-electric, or cable reel service.

They are safe because there is only one control lever, and the car moves only when the operator holds the lever.

Request "Walk-Along" Bulletin 1283.

ATLAS CAR & MFG. CO.
1100 IVANHOE ROAD
CLEVELAND 10, OHIO

ENGINEERS AND MANUFACTURERS SINCE 1896



Why this growing preference for Permanente 84 Ramming Mix!

As you can see from the chart above, sales of all ramming mixes to steel producers increased only 14% during the five year period ending December 31, 1955.

But during this same period, sales of Permanente 84 Ramming Mix increased *a whopping 49%*!

Why is Permanente 84 increasingly preferred by leading steel producers?

Briefly, here are the reasons:

Permanente 84 reduces the cost of maintaining furnace bottoms and banks. Repairs made with Permanente 84 stay put! Down time for hot-repairs is reduced because repairs made with Permanente 84 last longer. Steel production goes up—costs come down. Ideal for hot patching both open hearths and electric furnace banks and bottoms.

Order Permanente 84 now, and get extra steel tonnage at lower cost.

For more information call our nearest Sales Office: Kaiser Chemicals Division, 1924 Broadway, OAKLAND 12, Calif. . . . 3 Gateway Center, PITTSBURGH 22, Pa. . . . 518 Calumet Bldg., 5231 Hohman Avenue, HAMMOND, Indiana.

To obtain free copies of Kaiser Chemicals product literature write Kaiser Aluminum & Chemical Sales Inc., 1924 Broadway, OAKLAND 12, California, Dept. R6412.

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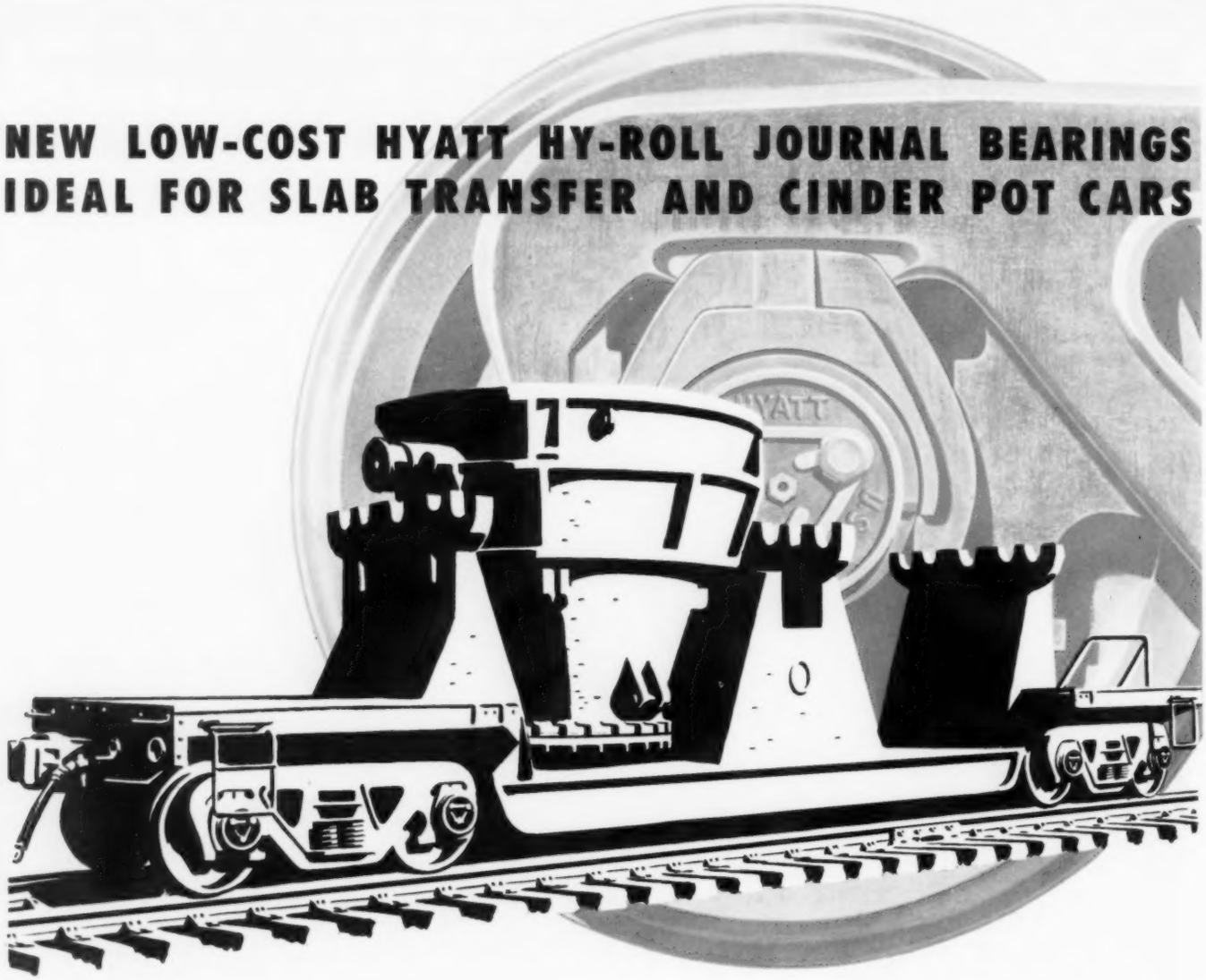
Kaiser Chemicals

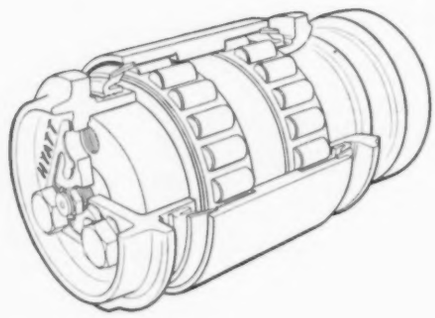
Pioneers in Modern Basic Refractories

Refractory Brick and Ramming Materials • Castables & Mortars • Magnesite • Periclase • Deadburned Dolomite

NEW LOW-COST HYATT HY-ROLL JOURNAL BEARINGS IDEAL FOR SLAB TRANSFER AND CINDER POT CARS



Simplified, Extra-Rugged Design with Straight Cylindrical Rollers Withstands Rough Handling



This new HYATT Hy-Roll Journal Bearing, recently introduced to cut the cost of roller bearing application and maintenance on railroad freight cars, is well suited for heavy-duty service on steel mill rolling stock such as slab transfer and cinder pot cars.

This bearing, available in sizes 5½ x 10, 6 x 11 and 6½ x 12, will fit all cars with standard AAR integral or pedestal type side frames. There are only four parts on the axle. The husky, high-capacity, straight cylindrical rollers are positively sealed in a 3-year supply of lubricant; dirt and water are sealed out. These features assure better ability to stand up under the heavy loads, shock and severe punishment of steel mill service. For improved performance and long-run economy, talk to your Hyatt Sales Engineer about Hy-Rolls today! Hyatt Bearings Division of General Motors, Harrison, N.J.

GM GENERAL MOTORS

HYATT HY-ROLL BEARINGS FOR STEEL MILL CARS

—nothing to wear out—and, only requires filling of the oil reservoir, eliminating the human element from lubrication work. A constant, uniform volume of fresh oil film is picked up by each bearing as it needs it, when it needs it. The questions of the right oil, the right amount and the right time are eliminated.

The clean, dry flow of air through the bearings acts as a coolant, cutting bearing heat as well as locking out dirt, which can cause bearing wear or damage.

Alemite Oil-Mist operates while the machine is in production, further increasing production time and reducing "stops" for oiling.

MAGNETIC BRAKE

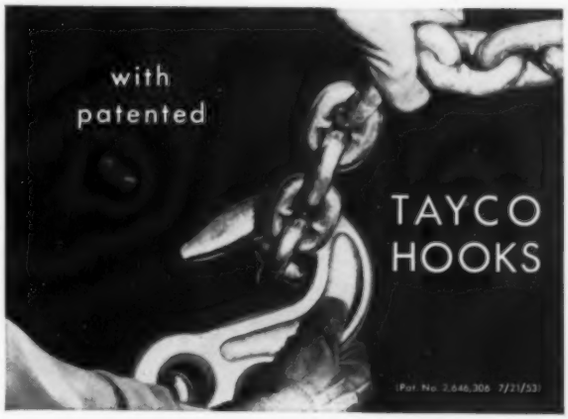
▲ Stearns Electric Corp. is offering a new magnetic disc brake for use in hazardous locations. Tested and approved by Underwriters' Laboratories, the brake is designed for application on electric motors to be operated safely in atmospheres where combustible dust creates a hazard to men and equipment.

The new brake is designated "dust-ignition-proof," for use in Class II, Groups E, F and G hazardous locations as defined by the National Electrical Code.

Stearns points out that now design engineers and motor manufacturers can *safely* provide the instant stop-start and holding advantages of magnetic disc brakes on electric motors where no *approved* brake formerly was available.

Offered in the Stearns 70 Series with maximum torque ratings of 10, 25, 50 and 75 lb ft, floor or motor mounting, the new dust-explosion-proof brake supplements a complete line of standard magnetic transmission equipment for use on $\frac{1}{20}$ to 100-

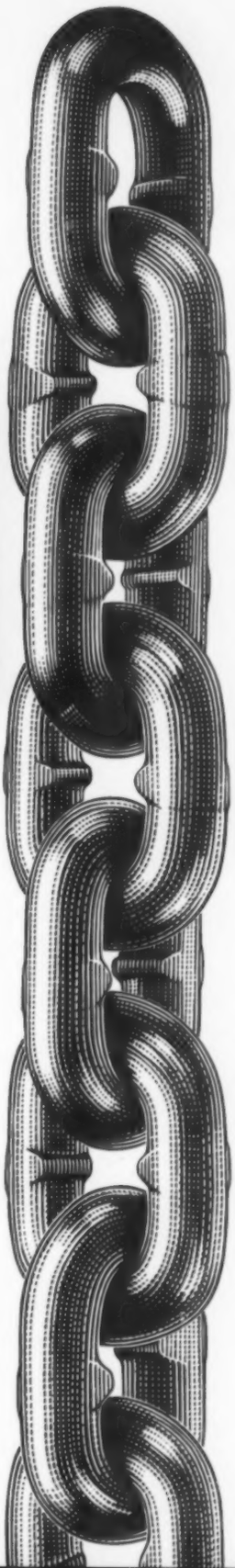
TM
factory made
ALLOY SLINGS



PLUS
GAMMA RAY
QUALITY CONTROL
on master, joiner and end links,
are the
toughest, safest,
most economical
you can use!

Rugged TM factory made Alloy Sling Chains rate ace high in industry for safety, long life and economy. Taylor's rigid standards, plus Tayco Hooks . . . Gamma Ray Quality Control . . . Controlled Atmosphere Heat-Treating of popular sizes and Taylor's special analysis alloy steel are a few of the reasons why! Investigate the many other advantages of using these famous slings now!

Call your DISTRIBUTOR today for all the facts and specifications!



TAYLOR MADE
A GREAT NAME IN
Chain SINCE 1873

S. G. TAYLOR CHAIN CO., INC.
A complete line of quality chain
Main office and plant — Hammond, Indiana
Eastern sales office and plant
3505 Smallman St., Pittsburgh, Pa.

Lapointe Machine Tool Company, Hudson, Massachusetts

FIRST OF ITS KIND IN THE WORLD!

...And It's Lubricated by Cities Service Pacemaker 400 T Oil!

LAPOINTE MACHINE TOOL COMPANY, originator of the broaching method of cutting metal over 50 years ago, has now originated the first vertical broaching machine with variable speed electro-mechanical drive.

Purpose of the huge, gear-driven machine is to increase tool life up to 500% through smoother operation, thus saving down time and producing more accurate work.

Selection of a lubricant for the new machine was of special importance because of the tremendous pressures it develops: normally 30,000 pounds, sometimes up to 60,000 pounds. Of the many brands of lubricants Lapointe tested, Cities Service Pacemaker 400 T had the necessary requirements for the job . . . so naturally, this superior lubricant got the job.

"We test the machines with Pacemaker 400 T at the factory and then put it in again when the broaches are assembled at the buyer's plant," says Lapointe. "It offers all the characteristics we need: Good film strength, high viscosity index, and exceptional anti-foam and anti-oxidant qualities. Needless to say, we're pleased and impressed with this Cities Service lubricant."

Like scores of others, Lapointe has discovered the search for a proper lubricant ends at the Cities Service label. Altogether, there are hundreds of Cities Service products for the exacting needs of industry. For more information, talk with your nearby Cities Service Lubrication Engineer. Or write: Cities Service Oil Company, Sixty Wall Tower, New York 5, N. Y.

Quick Facts About New Broaching Machine

USES: Now used for broaching aircraft engine turbine buckets, but can be adapted to general broaching.

ADVANTAGES: Increases tool life 400-500% through smoother operation, less down time. Produces more accurate work. Variable cutting speed: 12 to 75 FPM. Available in single or double ram models with 72" to 100" stroke.

Quick Facts About Pacemaker 400 T Oil

USES: Propulsion turbine units where oil is circulated under heavy pressure. Widely used in naval and commercial vessels, high speed industrial machinery.

ADVANTAGES: High viscosity index, excellent heat resistance and film strength. Chemically fortified against oxidation, rust, and foaming.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS

hp motors. Stearns also manufactures the UHF Class I, Group D brake—an approved explosion-proof model designed for locations where hazards exist due to explosive gases and vapors.

MOTORS

▲ The Crocker-Wheeler Division of Elliott Co. has completely redesigned their line of integral horsepower induction motors in NEMA frames (up to 30 hp). The new "Type N" motors are smaller, lighter, and more compact than former designs, incorporating more horsepower in less space.

Motor enclosures provide better protection. The conventional "open" motor is entirely superseded by a dripproof-protected design, which is also essentially splashproof. The new totally-enclosed fan-cooled design is a refinement of the ribbed frame motor.

Insulation of the new motor line takes full advantage of modern controlled synthetics, is high in dielectric strength and resistance to damage from moisture, heat, abrasion, and corrosion.

The standard bearing is an *open greaseable* design which is, in effect, enclosed in grease to eliminate corrosion from internal or external moisture. If preferred, *prelubricated* cartridge-type bearings may be specified.

WELD ANTI-SPATTER

▲ A new silicone-containing emulsion that cuts weld finishing time and costs by eliminating chipping, grinding, and other post-weld cleanup operations, has been introduced by Linde Air Products Co., Division of Union Carbide and Carbon Corp. Applied to the spatter area before arc welding, Linde X-7 Anti-Spatter, forms a thin protective coat over the weld metal. This invisible coat prevents molten spatter from sticking, and enables the operator to whisk away spatter with a cloth or spray after welding.

The emulsion is non-toxic, odorless, and non-flammable—assuring maximum safety and operator comfort. It can be used on any metal without affecting weld quality, and costs less than one cent per sq ft of treated surface to use on normal arc

(*Please turn to page 313*)

Makes Tightest Brickwork Linings in the History *of* Blast Furnace Construction

Steel mill men report SUPER #3000 Refractory Bonding Mortar Superior to All Others for making dense, tight joints that prevent flow of attacking gases

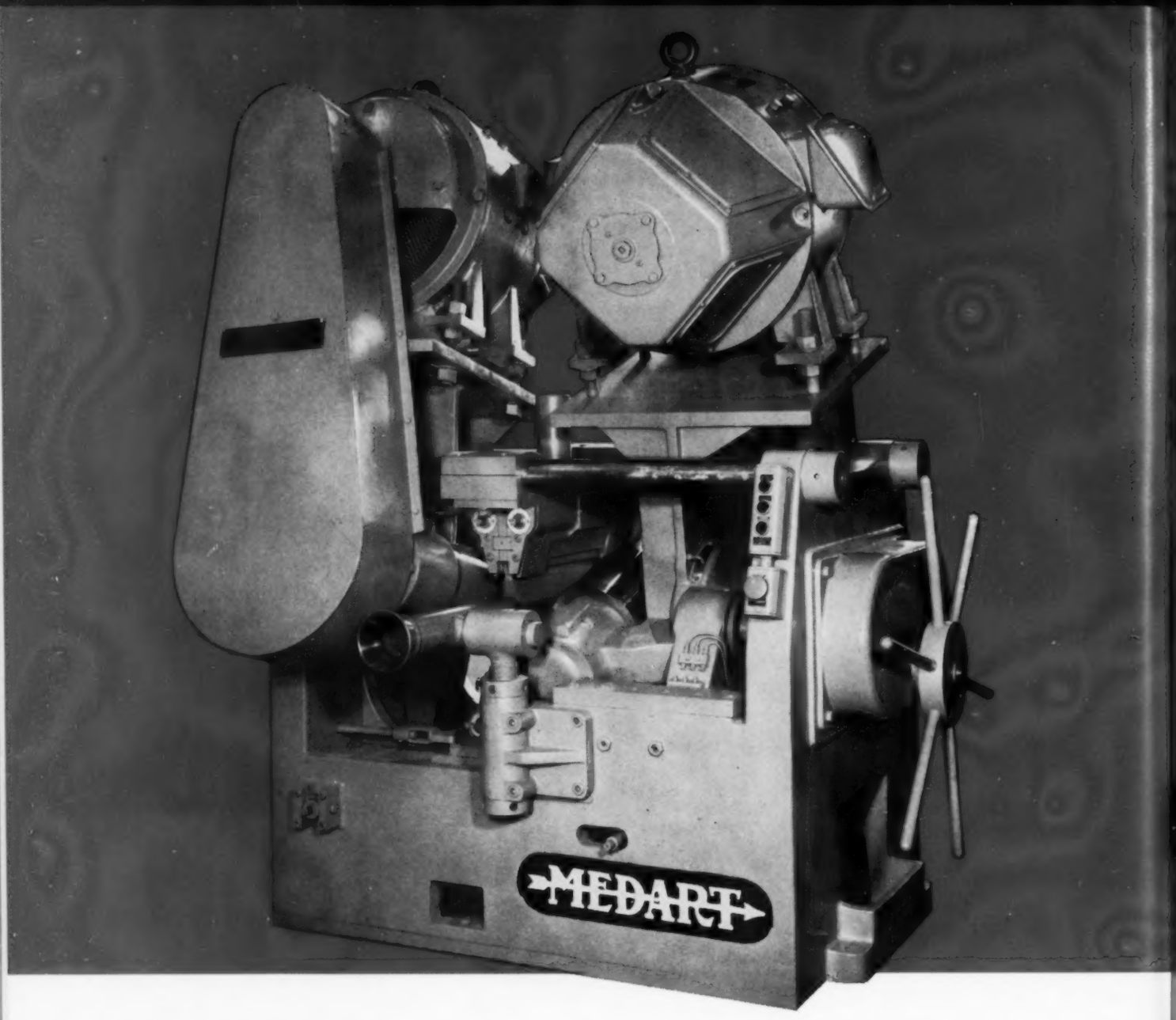
1. Has but a fraction of the iron content of other refractory bonding mortars, preventing carbon deposition.
2. Does not shrink or spall in the joints; has higher dried density than the brick itself; reduces channeling.
3. Strongest abrasion- and wear-resistant mortar on the market.
4. Has ideal heavy body and water-retention properties for best bricklaying practice on both ceramic and carbon brick.
5. Reduces downtime and maintenance labor and materials; increases productivity.
6. Unlike other mortars, Super #3000 has high bonding strength at low, medium and high temperatures.

REFRACTORY & INSULATION CORP.

R&I

REFRACTORY BONDING AND CASTABLE CEMENTS
INSULATING BLOCK, BLANKETS AND CEMENTS

136 WALL STREET - NEW YORK 5, N. Y.



BLAW-KNOX MEDART makes what it takes

for high speed straightening of cold finished stock

Designed around the principle used in the famous Blaw-Knox Medart 2 roll Rotary Straightener, the 2 & 2 Universal Straightener is especially adapted for high speed applications. It is widely used in a direct production line with a draw bench for high speed straightening of cold drawn bars.

In this machine, each roll is driven by its own motor through a completely enclosed V-Belt drive. This simplified arrangement keeps downtime and drive maintenance to a minimum. What's more it provides for control of throughput rates by varying the speed of the motors. Roll speeds are synchronized by means of electrical interlocks between the motors.

Space requirements are kept to a minimum through compact design and the small number of working parts. This compact set-up simplifies discharge of work from the machine, making it ideally suited to shorter length workpieces.

The Blaw-Knox Medart 2 & 2 Universal Rotary Straightener and Polisher is available in sizes to handle bars and tubes in diameters of ⅛" to 4½". Contact us for detailed information, technical assistance or service.

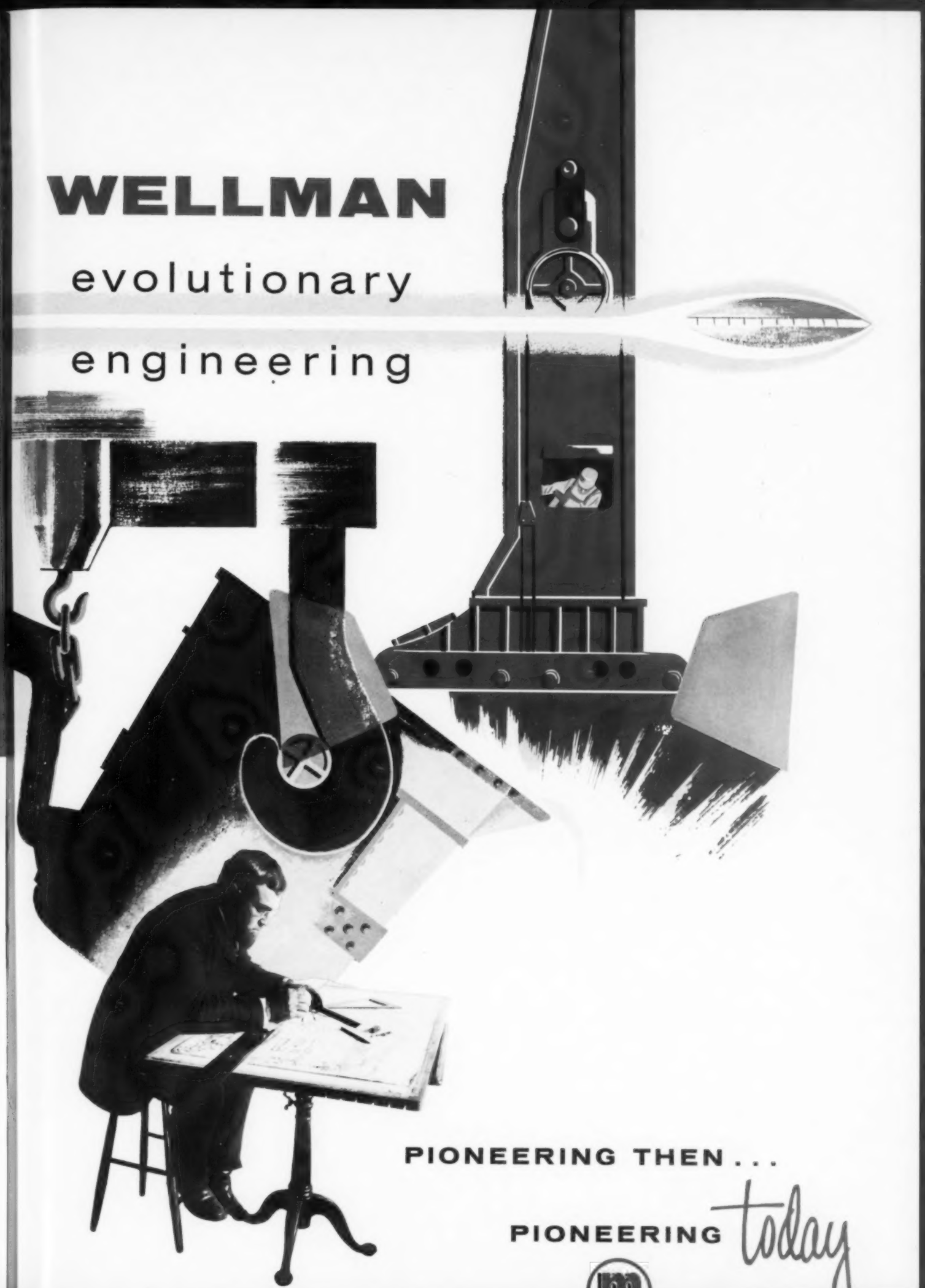
50th Anniversary
BLAW-KNOX
1906-1956

BLAW-KNOX COMPANY
Foundry & Mill Machinery Division
Blaw-Knox Building • 300 Sixth Avenue
Pittsburgh 22, Pennsylvania

WELLMAN

evolutionary

engineering



PIONEERING THEN . . .

PIONEERING *today*

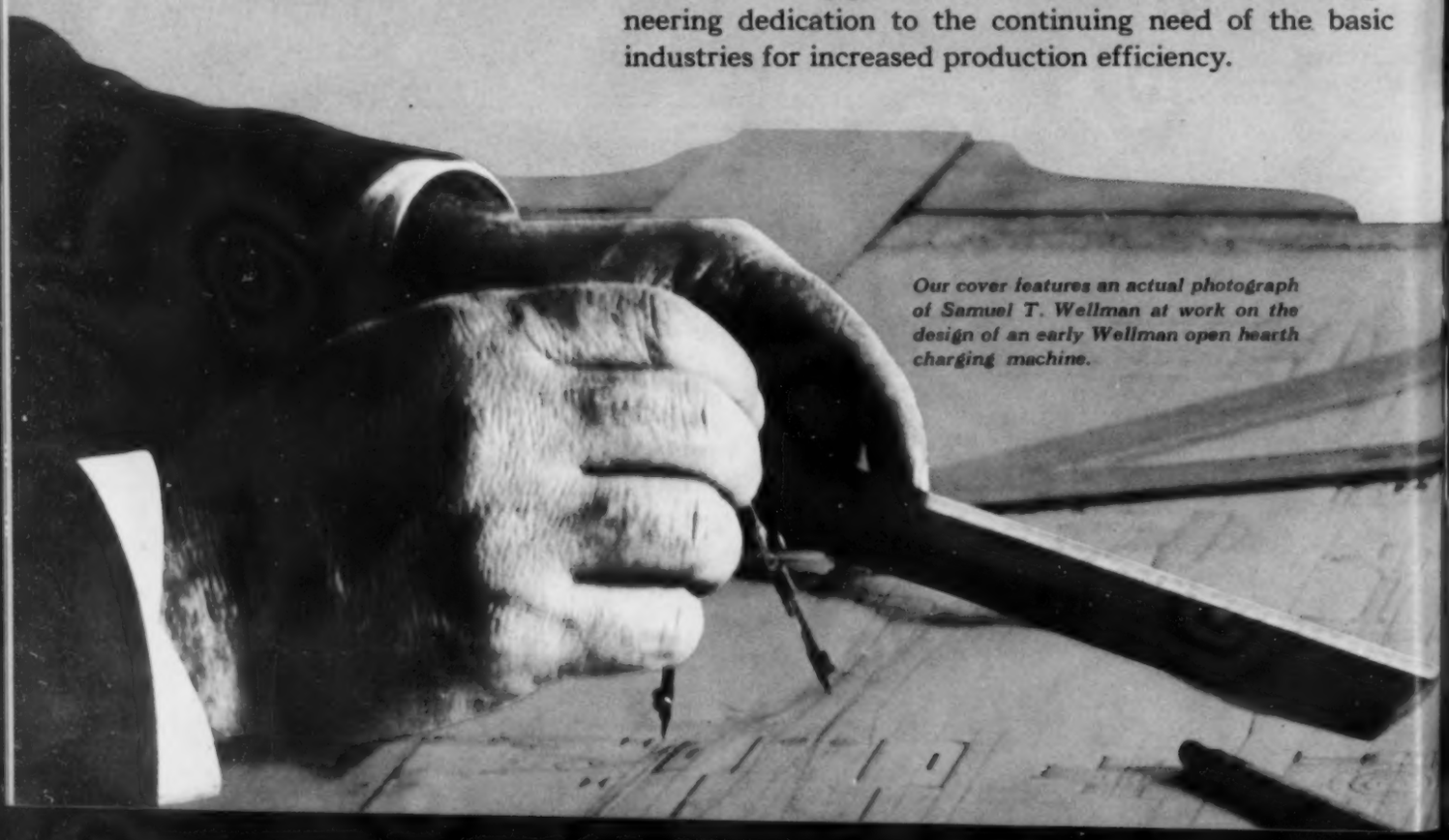
The Wellman Engineering Company celebrates

1896 **60** 1956

YEARS OF SERVICE T

Serving the stalwarts of America's great industrial community throughout the years of our mutual growth, Wellman creative engineering is identified with the development of unique mechanical entities which live, which perform the functions of many hands.

Building upon the pioneering work of its founder, Samuel T. Wellman, "father of the open hearth process of steelmaking in the United States", Wellman equipment for each succeeding generation has shown characteristic engineering dedication to the continuing need of the basic industries for increased production efficiency.



Our cover features an actual photograph of Samuel T. Wellman at work on the design of an early Wellman open hearth charging machine.

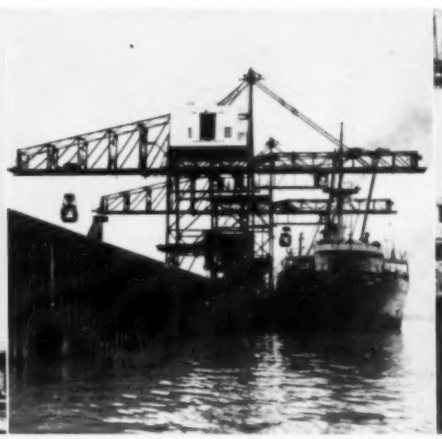
Pioneering still, Wellman engineering for the age of automation expresses an intimate understanding of the demand of today's heavy industry: mechanical equipment, more nearly human than ever, created from contemporary concepts of plants and processes, thus making Wellman's contribution to the American ideal of producing more goods for more people with greater economy.

In 1954, Wellman joined the family of related enterprises of McDowell Company, Inc., engineers and contractors serving the basic industries. Through this purposeful alliance, Wellman engineering and fabricating facilities are broadening the scope of the McDowell Method, which is at work on the new frontiers of turnkey planning . . . rooted in economics as well as engineering . . . and embracing design, construction and complete mechanical installation of going plants, delivered in operation.

Wellman charging machines remain the first choice of open hearth operators today, 68 years after Samuel T. Wellman created the first of them.

TO BASIC INDUSTRY . . . . . from mine . . .

Wellman 90-ton turn-over cardumper, with motor operated gates, at a mid-western steel plant.

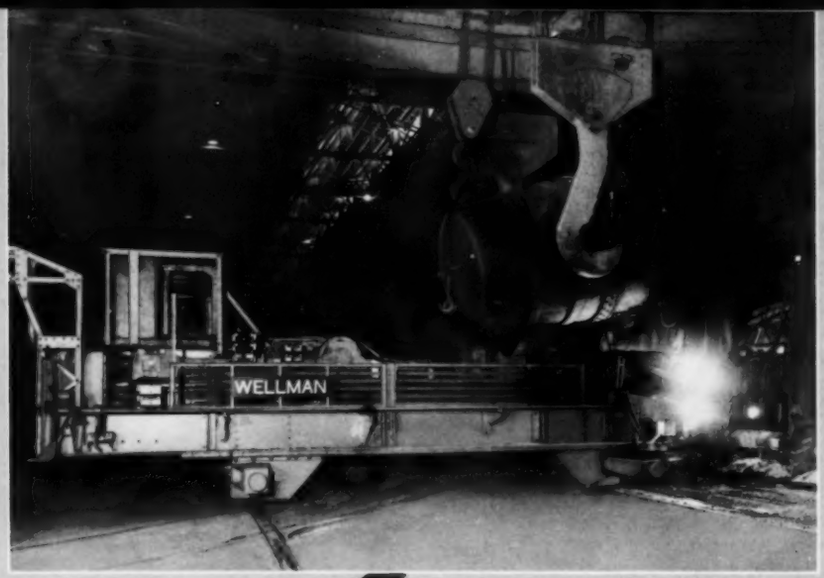


At a Canadian trans-shipping station, two Wellman 12-ton towers unload iron ore from Labrador.

Biggest Huletts ever built, these 20-ton machines operate on tracks curved to a 65 degree arc at a Lorain, Ohio, dock.

Wellman pulpwood handling pla storage problem for southern U. producer. Bridge pivots on pier to circle, is equipped with 1¼-cord grapple.

Anker-Holth air and hydraulic cyli standard and special designs, are swift leal power motions in modern indus

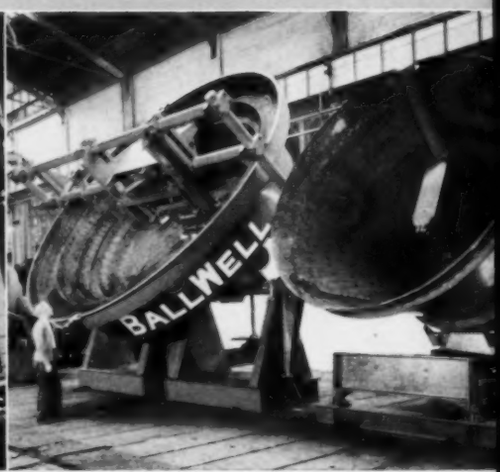


Wellman charging machines remain the first choice of open hearth operators today, 68 years after Samuel T. Wellman created the first of them.

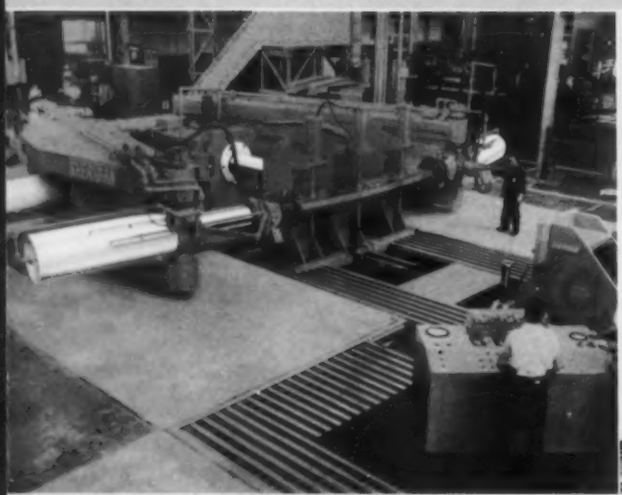
from mine...to mill...through finished product

Wellman pulpwood handling plant solves storage problem for southern U. S. paper producer. Bridge pivots on pier to negotiate circle, is equipped with 1¼-cord Williams grapple.

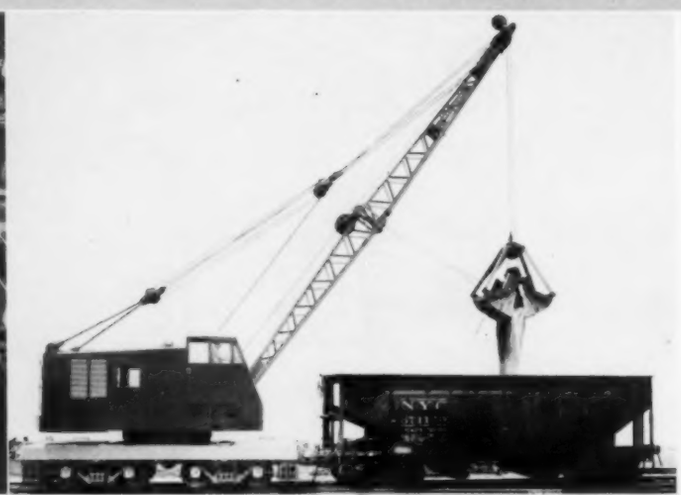
Big tough Williams 325 cubic foot ore bucket gives great service on the ore dock of a Cleveland steel mill. Wellman offers a complete line of Williams industrial buckets.



Wellman fabricates McDowell Company's Flying Saucer, newest development in fines agglomerating, and Dwight-Lloyd sintering equipment.



Anker-Holth air and hydraulic cylinders, engineered in standard and special designs, are swiftly replacing mechanical power motions in modern industry.



The all-new Wellman diesel electric locomotive crane features ball race rotation, speeds to 15 miles an hour, capacities from 25 to 80 tons.

m-
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nd

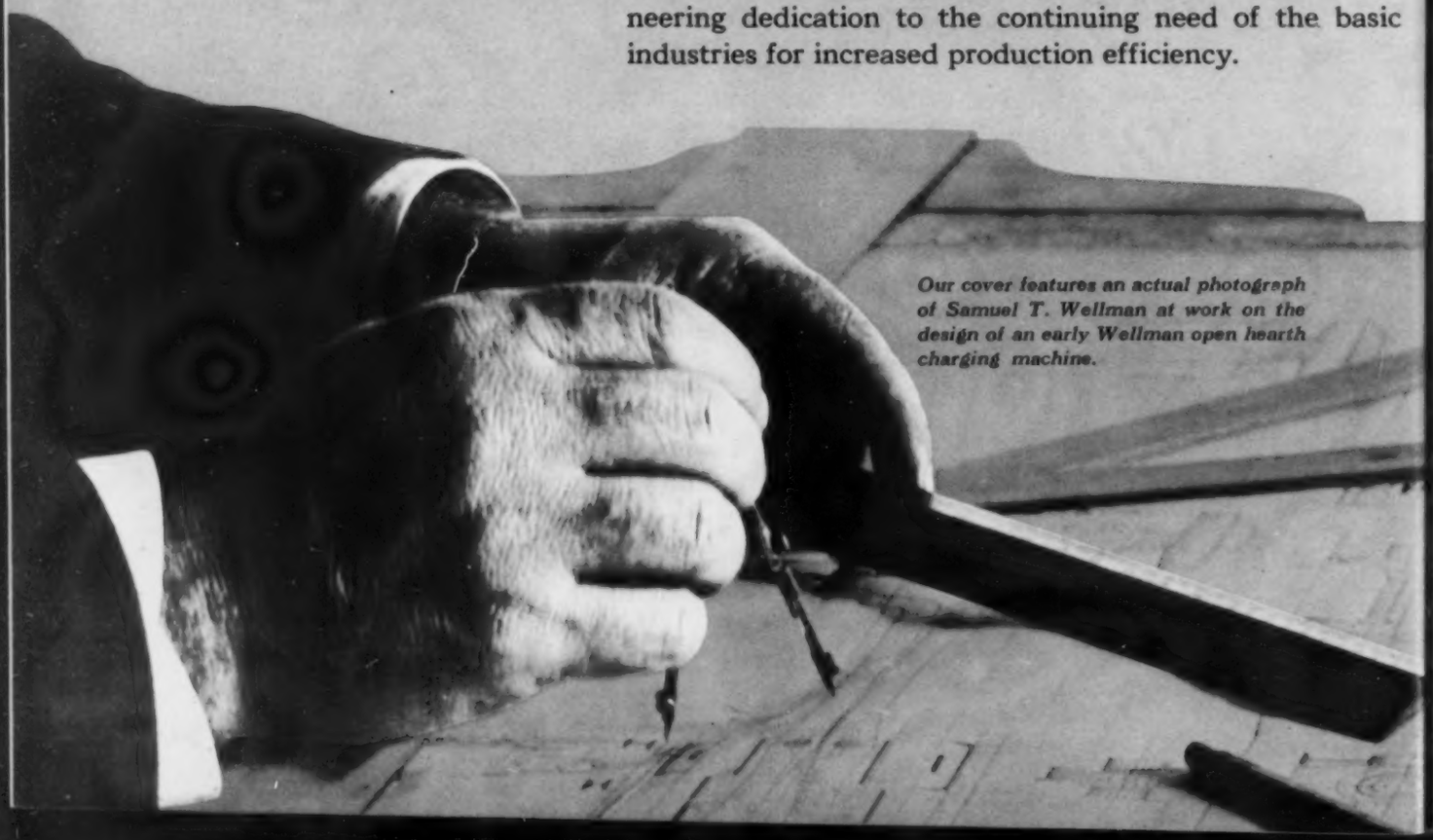
The Wellman Engineering Company celebrates

1896 **60** 1956

YEARS OF SERVICE

Serving the stalwarts of America's great industrial community throughout the years of our mutual growth, Wellman creative engineering is identified with the development of unique mechanical entities which live, which perform the functions of many hands.

Building upon the pioneering work of its founder, Samuel T. Wellman, "father of the open hearth process of steelmaking in the United States", Wellman equipment for each succeeding generation has shown characteristic engineering dedication to the continuing need of the basic industries for increased production efficiency.



Our cover features an actual photograph of Samuel T. Wellman at work on the design of an early Wellman open hearth charging machine.

in Steel-Making Machinery

Wellman builds a complete range of coke plant equipment, including coal charging cars, coke guides, coke oven doors, combination coke pusher, coal leveler and door extractor machines, coke side door extractors, and coke quenching cars.

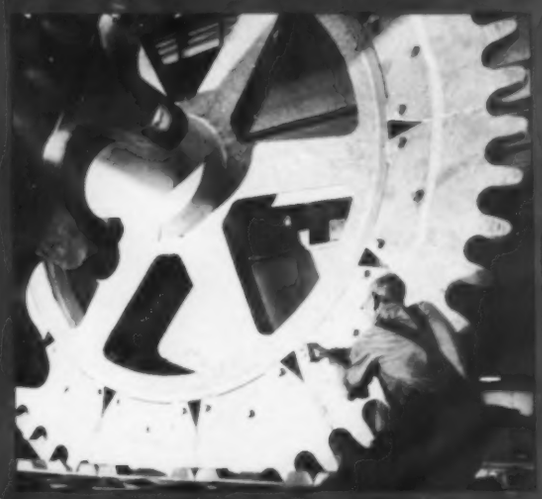
TO BASIC INDUSTRY

in Bulk Materials Handling Systems

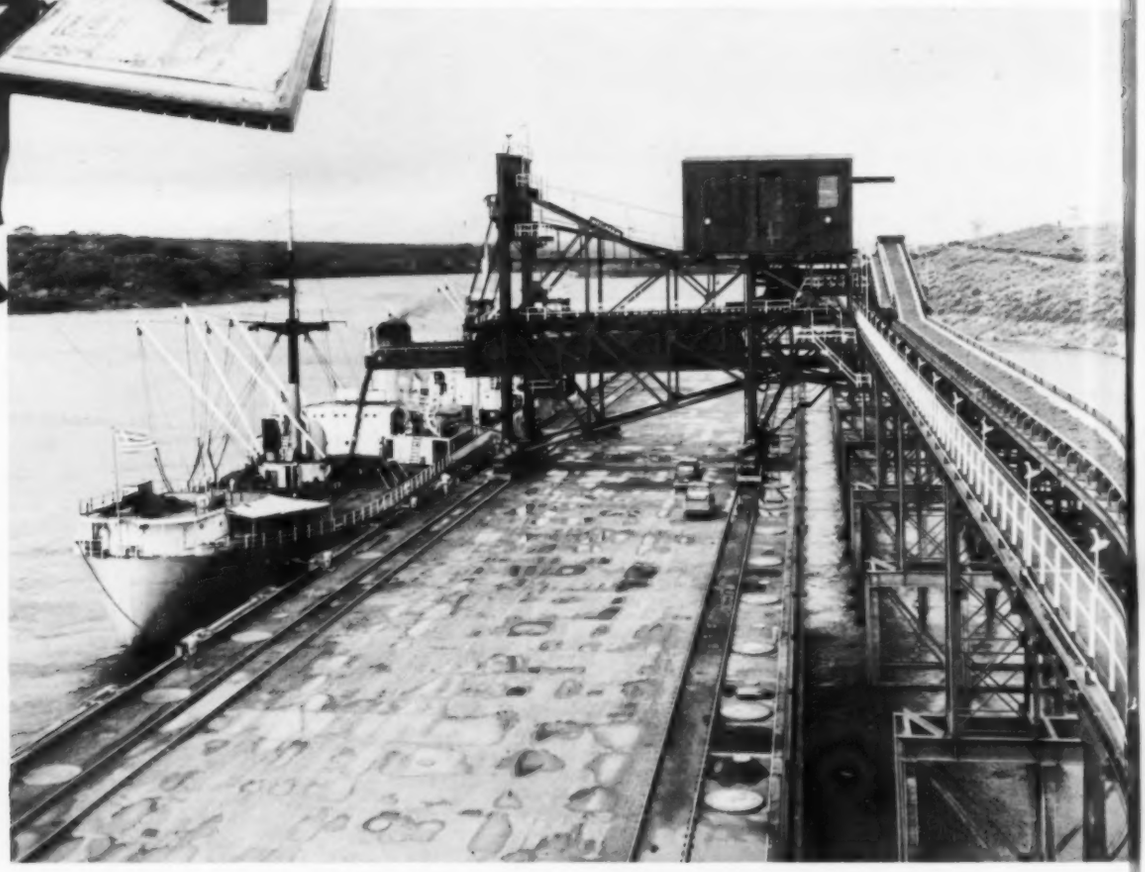
World's largest belt conveyor iron ore stocking bridge classifies Venezuelan ores.

in Special Fabrications

Skilled craftsmen working with precision tools and equipment in the Wellman shop fabricate machinery of every size and complexity.



at Wellman everything begins *here*



Wellman traveling shiploader handles 6,000 tons of iron ore per hour in Venezuela.

1896 60 1956

YEARS OF SERVICE TO BASIC INDUSTRY

Wellman's cultivated place in the field of development engineering is the endowment of its illustrious founder, Samuel T. Wellman, who brought the open hearth process of steelmaking to America.

Sam Wellman may not have known the word, but the prolific issue of his drafting board is alive with automation — a genesis manifested then as now by talented mechanical entities that live and do a job.

Today the Wellman heritage is expressed by its inquisitive engineering mentalities, exploring the manifold challenges of the basic industries — in bulk materials handling, heavy hoisting, steelmaking, gas producing, etc., all dedicated to greater production efficiency.

THE WELLMAN ENGINEERING COMPANY

7000 CENTRAL AVENUE · CLEVELAND 4, OHIO

THE McDOWELL FAMILY OF RELATED ENTERPRISES

McDowell Turnkey Plants • Dwight-Lloyd Research Laboratory • Wellman Bulk Materials Handling Systems and Steelmaking Machinery • Anker-Holth Power Cylinders • Dwight-Lloyd Ore Beneficiating Plants • ABCs Belt Conveyor Scales • Williams Buckets • Wellman Locomotive Cranes

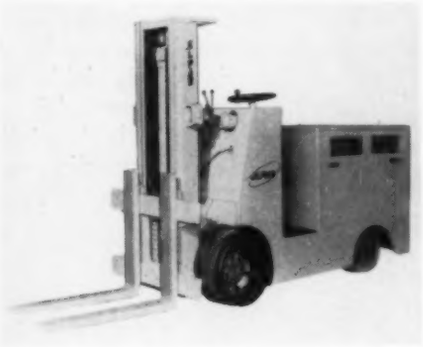
(*Continued from page 305*)

welding operations. By using a cloth, brush, or fog spray, ready-to-use Anti-Spatter can be applied quickly and easily any time up to weeks before welding. It will not "cake up" on the workpeice or fixtures, and in most cases, no special post-treatment is required where the weld surface is to be painted.

FORK TRUCK

▲ A new electric-powered, stand-up, center control fork truck, with a capacity of 10,000 lb, has been announced by the Elwell-Parker Electric Co.

The new model, designated as its "RIOT," features front wheel drive, rear wheel steer, and has a travel



speed of 4.5 mph without load, 4 mph with a full load.

Other features of the truck include contactor control with automatic acceleration; four speeds forward and reverse. Direction and acceleration are through a single hand control lever. The frame is of heavy gauge reinforced formed steel plates electrically welded into a rigid box structure.

TUBING CAPS

▲ Slip-over and roll-on end caps made of neoprene that effectively seal out air, moisture, corrosive fumes, dust—and small animals, is available from Protokap, Inc.

By simply adding a small amount of dehydrating agent before slipping on the easily fitted caps, the inside of tube stock is protected from corrosion. Ideal, too, for threaded pipe, the new caps retard drying of thread dope and keep the threads free of sand and grit.

Two types are currently available: a lightweight roll-on cap for pipe 2 to 10 in. in diameter; and a heavier,

GREENBERG — BUFFALO

NO MORE WAITING days or weeks for new or rebuilt sling chains to reach you from the factory. Now, with all components furnished by your Herc-Alloy Distributor, you can assemble or rebuild your own Herc-Alloy slings in minutes.

SECRET TO NEW...FAST, SLING CHAIN SERVICE.
The Hammerlok Coupling Link makes it possible for anyone who can drive a nail to assemble or rebuild a sling chain. No peening! No welding! Hammerlok is rugged...reusable...safe. Endorsed by leading alloy chain users.

Write us or call your CM Chain Distributor today for catalog, prices and assembly chart.

COLUMBUS McKINNON CHAIN CORPORATION
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In Canada: McKinnon Columbus Chain Ltd., St. Catharines, Ont.

HERC-ALLOY® HAMMERLOK®

CM HOISTS AND CHAIN

"THIS LUBRICANT ENABLED US TO INCREASE PRODUCTION"

says—PITTSBURGH TUBE COMPANY

"Our 70,000 pound Draw Bench was designed to operate at a maximum of 80 feet per minute, full load. We decided to increase the drawing speed on lighter tubing to 100 and 104 feet per minute. This overloaded the Speed Reducer, however, causing it to overheat. We tried four different makes of oils without success before trying LUBRIPLATE A.P.G. 90. With LUBRIPLATE, we are able to pull heavier tubing than before at 104 feet per minute without the Reducer overheating."

R. S. Vorous
Maintenance Engineer

REGARDLESS OF THE SIZE AND TYPE OF YOUR MACHINERY, LUBRIPLATE LUBRICANTS WILL IMPROVE ITS OPERATION AND REDUCE MAINTENANCE

LUBRIPLATE LUBRICATION

MAKES CARS AND TRUCKS RUN BETTER AND LAST LONGER

LUBRIPLATE H.D.S. MOTOR OIL . . . THE OIL THAT NEEDS NO ADDITIVES

For nearest LUBRIPLATE distributor see Classified Telephone Directory. Send for free "LUBRIPLATE DATA BOOK" . . . a valuable treatise on lubrication. Write LUBRIPLATE DIVISION, Fiske Brothers Refining Co., Newark 5, N. J. or Toledo 5, Ohio.

slip-on cap for 2- to 20-in. diameter piping. The standard slip-on covers have a wall thickness of about ⅛ in.

Made of Du Pont neoprene, the new end caps stand up to rough handling and repeated re-use. Neoprene also is highly resistant to oil, acids and other chemicals, sunlight, and weather.

While the new caps were designed primarily for stored piping, they are equally effective for protecting heat exchanger tube bundles, well casing, and various other tubular goods for oil field and refinery applications. The neoprene covers can be used to afford complete protection all the way from supplier to installation.

CONVEYOR

▲ For conveying heavy items such as spiral metal turnings, stampings, castings, forgings, etc., Hapman Conveyors, Inc., is offering the new Pan-Link conveyor. No conventional chain is included in the design. Instead, precisely-built flat side skirts serve as links, insuring correct pitch, and also as sides to contain conveyed materials.

Another unique feature is the mounting of wheels on an axle rod which passes through a set of double bushings. The smaller diameter inner bushings are welded to the rear edge of leading apron pan, while larger diameter outer bushings at both sides are welded to the leading edge of following pan.

This patented construction is said to be especially advantageous when carrying abrasive materials, as it eliminates the abrasion and rapid wearing out of one pan edge against another. Coolant fluids can also drain out between pans.

Conveyor housing is a girder-like box section, with two pairs of longitudinal rails on which loaded and return apron rolls. Rails also reinforce the housing, reducing the need for exterior support. Modular conveyor sections are built in standard 10 ft lengths for assembly to any length required. Apron design is highly flexible, permitting conveyors with one drive unit to operate horizontally, with ascending or descending sections.

(*Please turn to page 318*)

. . . complete lamp protection with *Adalet* vapor-tight lighting

Inside or outside, wherever the lighting need, get better protection, greater safety with Adalet vapor-tight and weather-proof lighting.

From junction box to reflector, globe and shock-proof guard (that can't shake off), Adalet has a complete line . . . quality built for rugged service, engineer-designed for better lighting. 100, 200 and 500-watt sizes. Get the whole story—send for Catalog Section E.

LIGHTING FLEXIBILITY

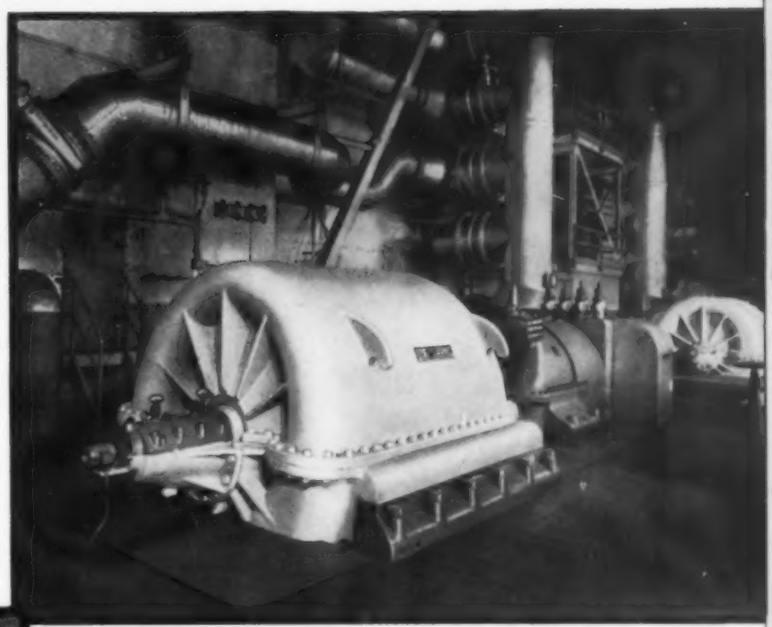
WIRING FLEXIBILITY

MOUNTING FLEXIBILITY

THE *Adalet* MANUFACTURING COMPANY
14300 LORAIN AVENUE • CLEVELAND 11, OHIO

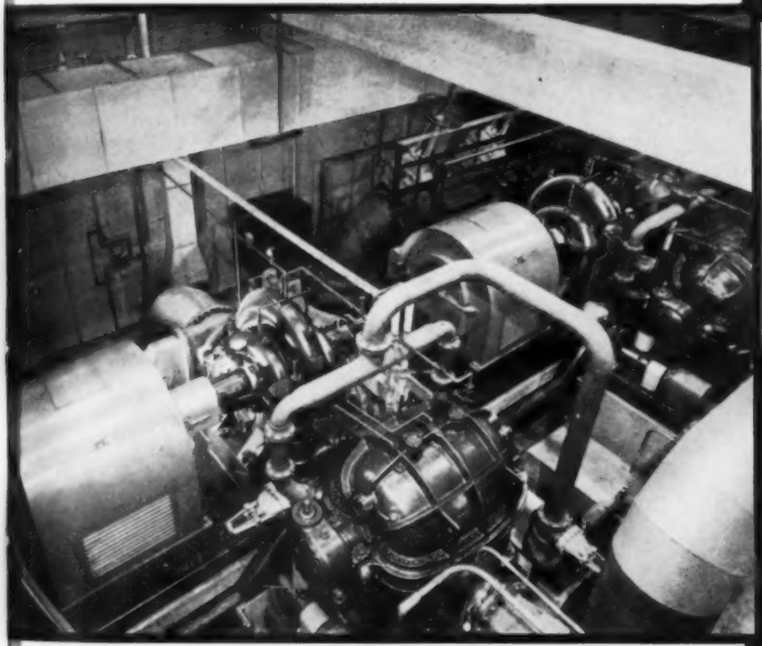
DE LAVAL
CENTRIFUGAL BLOWERS AND PUMPS

stay on the line for years at **Jones & Laughlin**

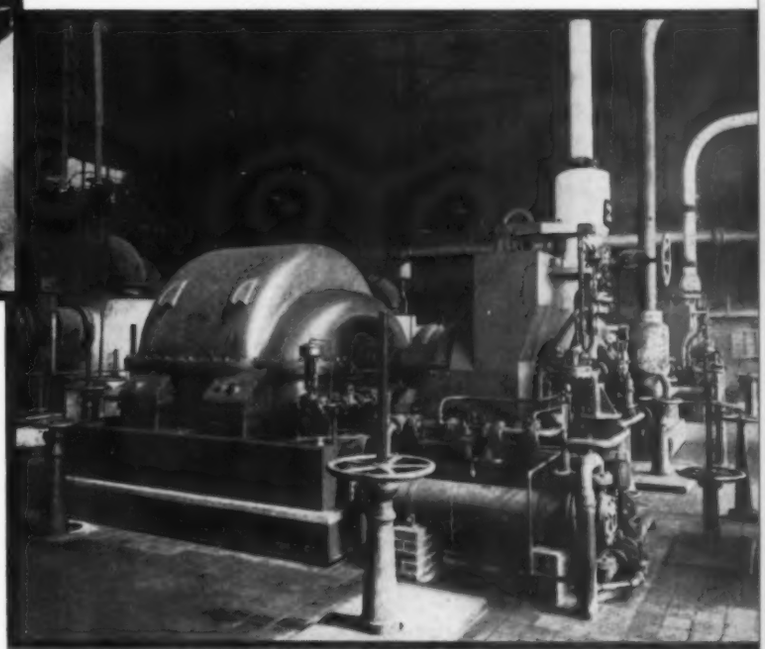


Jones & Laughlin reports: "*We have been using De Laval equipment for many years, and from our experience we have learned that De Laval blowers and pumps are inexpensive to maintain. Service is excellent. We can get spare parts quickly.*"

Three De Laval 22,000 gpm motor-driven pumps are on the job at Jones & Laughlin Steel Corporation in Pittsburgh, Pa. These units are used to pump river water to the open hearth and general mill. Installed in October 1951, these three pumps "have not had any downtime at all since their installation except for periodic inspections," Jones & Laughlin reports.



These two De Laval centrifugal blowers, each rated at 100,000 cfm, are in use 24 hours per day, seven days per week except for a yearly inspection period. Since installation, there has been only 24 hours downtime in one of these blowers with a maintenance cost of about $400. "That's very little for this type of equipment," says the Jones & Laughlin blower room foreman.



This is one of three De Laval gas exhausters, operating at 48,000 cfm around the clock. Two of these units can handle maximum capacity; the third is used as a spare. Jones & Laughlin says, "Without good gas exhausters you would have to 'bee hive' (open the top and permit the gas to go free), thus losing our by-product."

Send for Bulletin 0504

DE LAVAL *Pumps and Blowers*

DE LAVAL STEAM TURBINE COMPANY
870 Nottingham Way, Trenton 2, New Jersey

NOW GENERAL ELECTRIC LIMITAMP* STARTERS OFFER EXTRA SPACE SAVINGS BY ELIMINATING FUSE CABINET

General Electric Limitamp starters now offer you greater savings of valuable floor space . . . savings made possible by eliminating the need for an extra fuse cabinet. Previously, starters controlling high-horsepower motors required *six* double-banks of fuses, making necessary an extra fuse cabinet.

Now, through use of higher-capacity Type EJ-2 fuses, G-E Limitamp starters of this type will be delivered to you with *three* double-banks of fuses, thereby eliminating need for the extra cabinet. This single new feature of G.E.'s high-voltage motor control saves over five square feet of space.

HERE ARE MORE FEATURES ONLY LIMITAMP CONTROL OFFERS

Savings of floor space is but one benefit of General Electric Limitamp control. There are many more. For instance:

- easy installation and connection, made possible with roll-out contactor unit and centrally located bus compartment
- increased personnel safety, provided by three-phase disconnect switch
- flexible arrangement of units and added space savings with all connections made from front
- complete range of modifications to meet any installation requirement

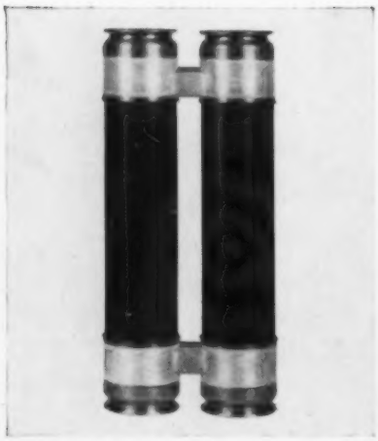
*Reg. Trade-mark of General Electric Company

TAKE ADVANTAGE OF THESE BENEFITS NOW

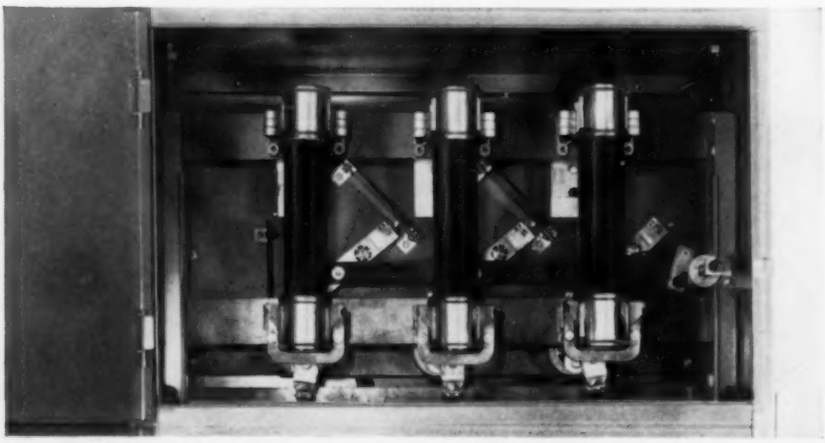
Don't be satisfied with "old-fashioned" high-voltage motor control: Specify General Electric's Limitamp control—*leader in design and performance*. Contact your G-E Apparatus Sales representative today, or write Section 783-1, General Electric Company, Schenectady, New York. *Industry Control Dept., Roanoke, Virginia.*

Progress Is Our Most Important Product

GENERAL ELECTRIC



HIGHER CAPACITY of EJ-2 fuses eliminates need for extra fuse cabinet.



ONLY HALF AS MANY FUSES—three double banks—are now used in the General Electric Limitamp starters controlling motors of 700 horsepower and above.

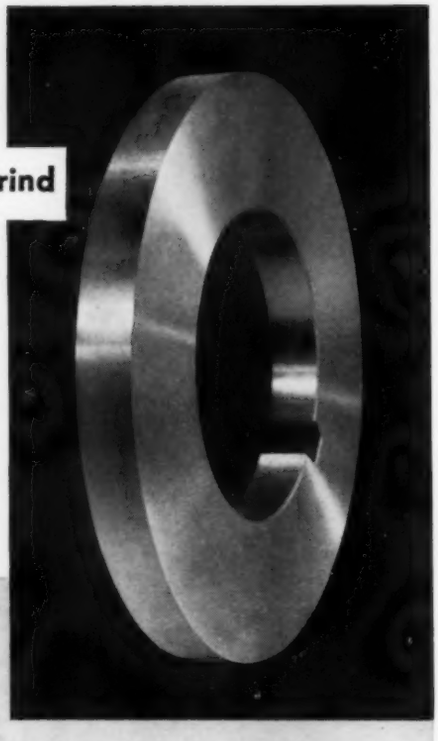
. . . LEADER IN DESIGN AND PERFORMANCE

COWLES

TRIMMING KNIVES

produce more tonnage per grind

Cowles knives stay on the job longer. They keep mills in continuous production without downtime for knife changes. Manufactured from individually hammered forgings, and heat treated to assure maximum durability, they meet industry's most exacting requirements. Complete range of sizes. **Prompt delivery.** Widely used by all principal producers and processors. Let us quote on your requirements!



COWLES
TOOL COMPANY
2086 WEST 110th STREET
CLEVELAND 2, OHIO

Specializing in the Manufacture of

ROTARY SLITTING KNIVES • SPACING COLLARS • GANG TOOLS • EDGING ROLLS • CUT-OFF KNIVES • SEAM GUIDE ROLL FINS • SEAM GUIDES • WIRE DRAWING TOOLS • STANDARD AND SPECIALLY ENGINEERED TOOLS FOR ALL FERROUS AND NON-FERROUS PROCESSING, TRIMMING AND FORMING REQUIREMENTS.

Markal
PAINTSTIK MARKERS

Use like a pencil . . . a complete line for every application. Marks are weatherproof, fadeproof, permanent.

Cold Markal Paintstik for surfaces 50° to 150°F.
Hot Markal Paintstik for surfaces 150° to 2000°F.

Consult our Engineering Service on marking problems . . . no obligation.

Send for catalog.

The Mark of Quality
MARKAL COMPANY 3087 West Carroll Avenue, Chicago 12, Illinois

(*Continued from page 314*)

Sections are available in heavy-duty and extra heavy construction, with pan thicknesses from 12 gage to ½ in., and width from 16 in. to 72 in. across.

GAS BLOWER

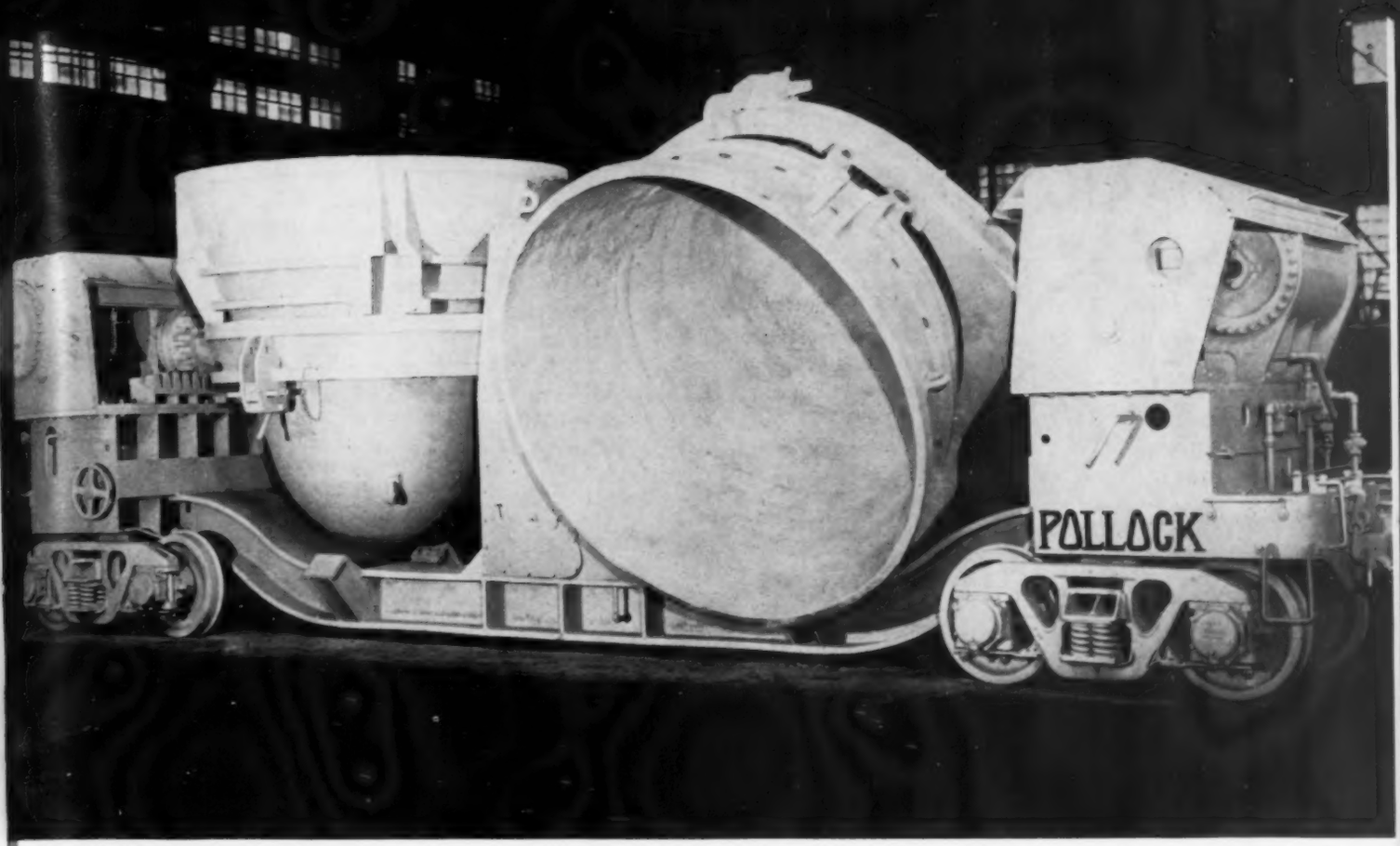
▲ To prevent oxidation during its annealing processes, an eastern steel company employs a specially prepared reducing atmosphere. The prepared atmosphere is supplied at pressures ranging from 4 to 10 psig by seven "Standardaire" Model 45B11 gas blowers, each having a capacity of 400 cfm, manufactured by the Read Standard Corp.

These rotary blowers compress the gas in the pockets that form between male (lobed) and female (grooved) rotors during the cycle of rotation. The rotors are each 11 in. long and are on parallel shafts with a center-to-center distance of 4½ in. They are encased within a one-piece housing, which has ports for inlet and outlet diagonally disposed on opposite sides. Since there is no actual physical contact at any time between the rotor lobes, housing or end closures, no internal lubrication is required, and the gas is not polluted by contact with grease or oil.

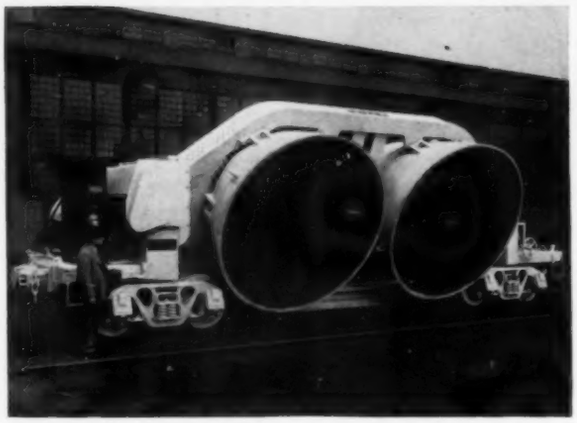
Leakage loss is held to a minimum by maintaining clearances on the order of a few thousandths of an inch between the meshing rotors, housing and end closures. Labyrinth seals are employed to restrict the leakage by throttling the compressed gas through a number of parallel grooves. These grooves, of very small clearance, are formed between the seal bushing and the grooved bearing spacer on each rotor shaft.

Book Reviews

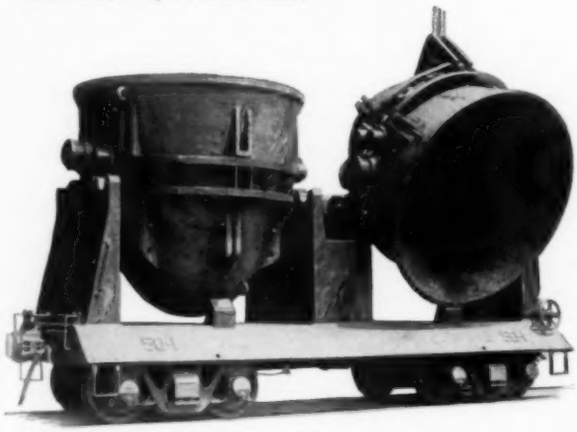
"Resistance Welding—Theory and Use," presents for the first time resistance welding in clear, everyday language so it can be understood without previous knowledge of welding. Yet, the subject is so thoroughly covered and so authoritative and up to date that it will interest welding engineers, metallurgists, designers and shop personnel. Included are full details of the six resistance-welding processes, machines, controls and



Double pot, air operated Pollock slag car dumps to either side. Pots dump separately or together.



Pollock double pot, electrically operated car dumps pots simultaneously to either side.



Double pot, crane dumped slag car.

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The type and size slag car you can use most efficiently and economically depends on three things: existing facilities, clearances and the use of the car. If you process slag, an electric dump gives you slow, even distribution. If you have a railroad crane or crane at the dump you can use the crane type. If you have adequate air capacity you will want the air operated cars, because they furnish the best means of dislodging skulls. The best way to select the proper car for your use is to consult the experts at The William B. Pollock Company. Most steel producers do. Pollock has built more slag cars, of all types, than anyone else in the world.

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electrodes, welding of different metals, weld quality, inspection and testing.

The new book, published by the Reinhold Publishing Corp., 430 Park Avenue, New York 22, N. Y. at a price of $4.50, is one of a long list of important contributions to the industry by the American Welding Society.

"Atmospheric Pollution—Its Origin and Prevention," second edition, by A. R. Meetham, D. Sc., has recently been published by Pergamon Press, Inc., 122 East 55th Street, New York 22, N. Y. The book contains 302 pages, 8½ x 5½ in., is cloth bound, and sells for 63s net. This second publication contains revised and recent information brought to light by the many recent technical conferences in the United States and the symposia held in England. Alterations have been made in various places throughout the book and a new chapter on recent developments containing three parts dealing with pollution in fogs, trends in atmosphere, and pollution from nuclear reaction, is presented as a "word in season" and not intended as the last word on these developments. In addition, the scope of the book covers fuels; power and electricity; industrial furnaces; domestic fires; atmospheric pollution—measurement, distribution, changes to, effects of, and prevention; as well as a discussion of British law and its administration.

"Factory Electrification," by F. T. Bartho and C. H. Pike, recently published by the Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y., contains 398 pages, 5½ x 8½ in., is cloth bound, and sells for $12.00. This book discusses factory electrification in terms of principles, and the capabilities and limitations of the various forms of equipment, with descriptions of representative types, and provides information about basic electrical equipment in a comprehensive and original form. No attempt has been made to deal with special electrical equipment information such as is supplied by manufacturers. Following a chapter on the general requirements for electrical installations, there are chapters devoted to main distribution switchgear, power transformers, cables and wiring systems, a-c induction and 3-phase commutator motors, d-c motors, synchronous motors and power-factor improvement, motor control gear, and motor application. The subject matter is amply illustrated and explained by photographs, diagrams and line drawings, equations, tables, charts and graphs.

"The Petroleum Refinery Engineer's Handbook," by J. F. Strachan has recently been published by the Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. The book contains 168 pages, 10 x 7½ in., is cloth bound, and sells for $15.00. This book is in essence a revision of "Practical Inspection of Oil Refinery Equipment," and generally the field as covered in the earlier edition is unaltered. The present book, however, discusses the most recent methods of inspection and recording developed and used in modern oil refineries, and includes the latest experiences, covering a wide field of operation, of all

(*Please turn to page 344*)

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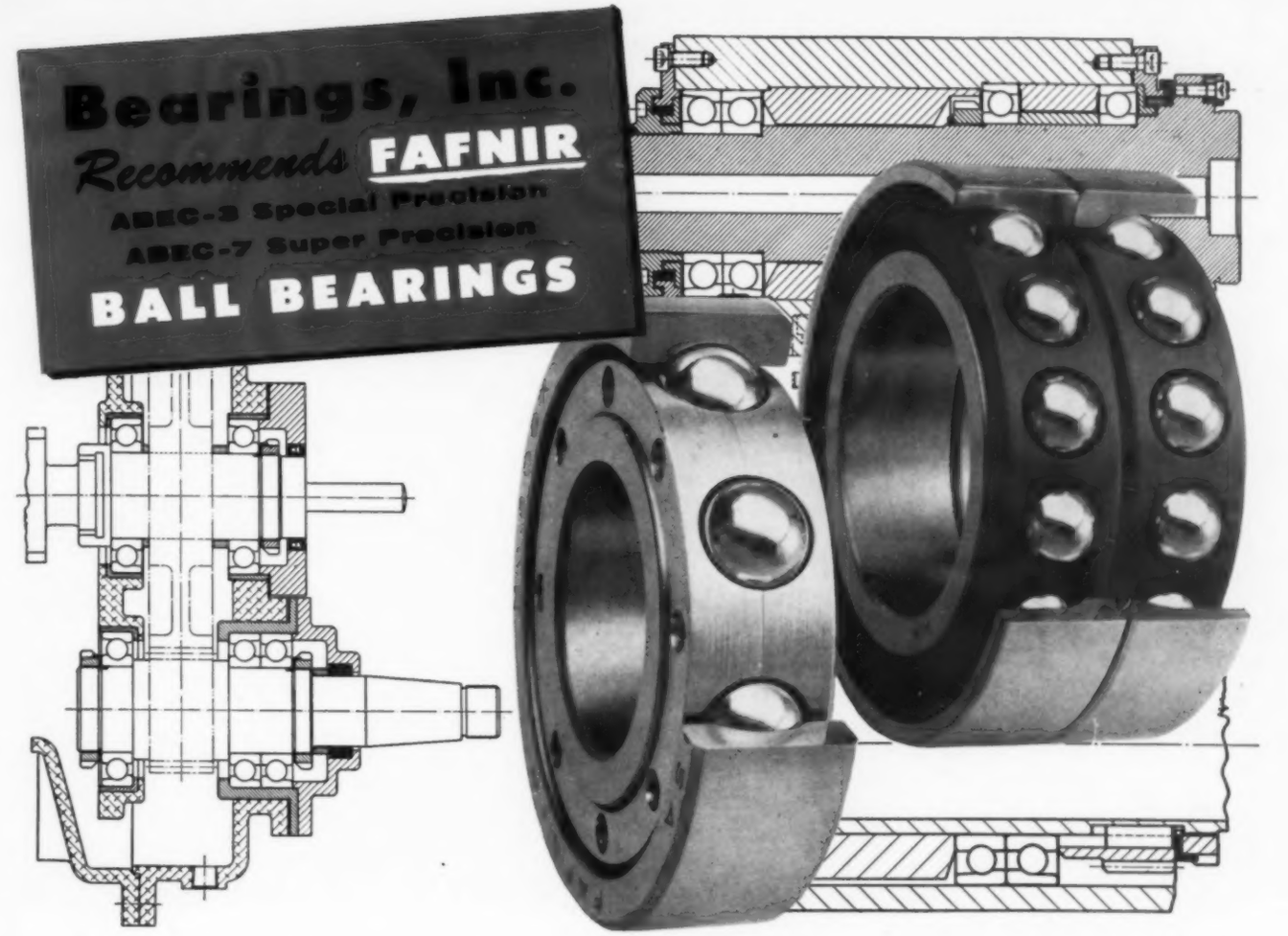

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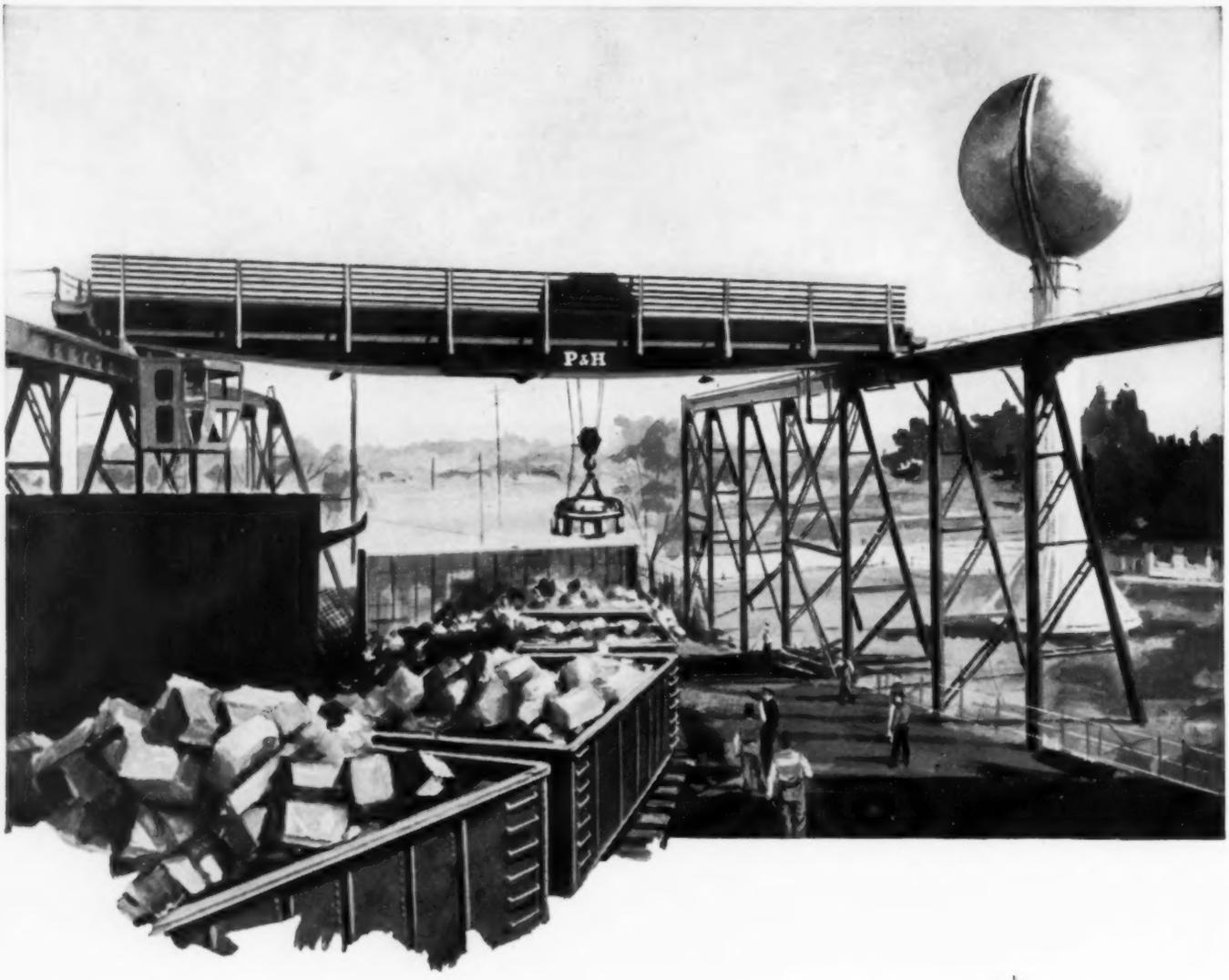

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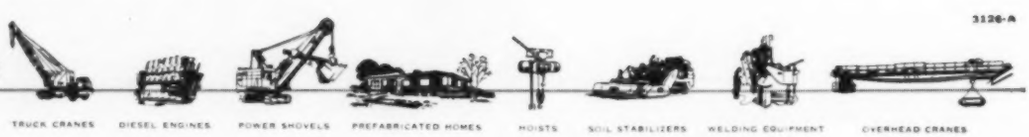

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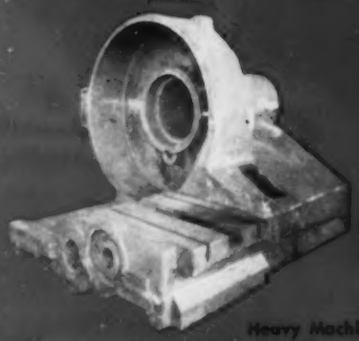

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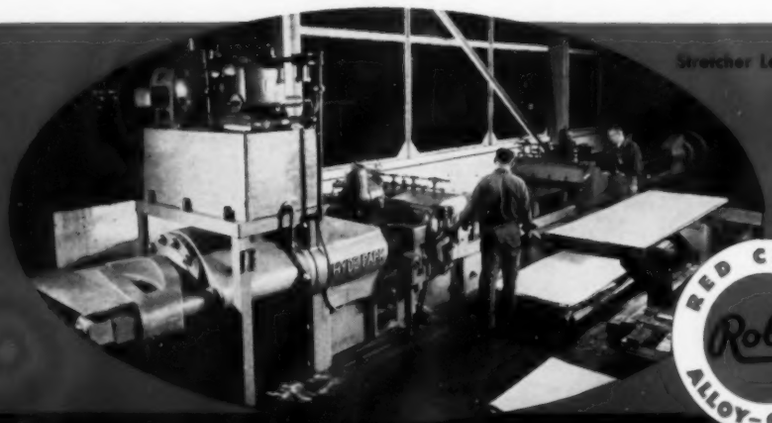

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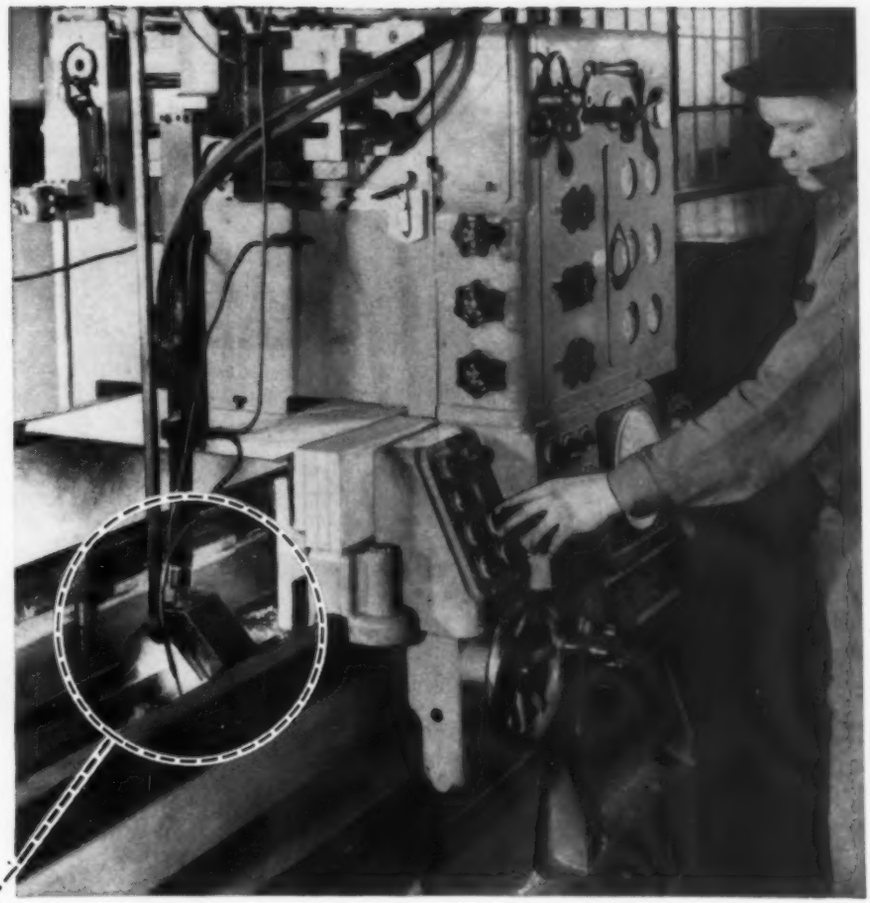

Cross-section view shows uniform depth of hardened surface.

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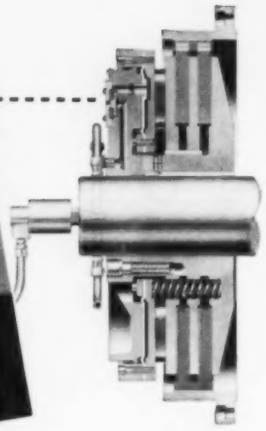

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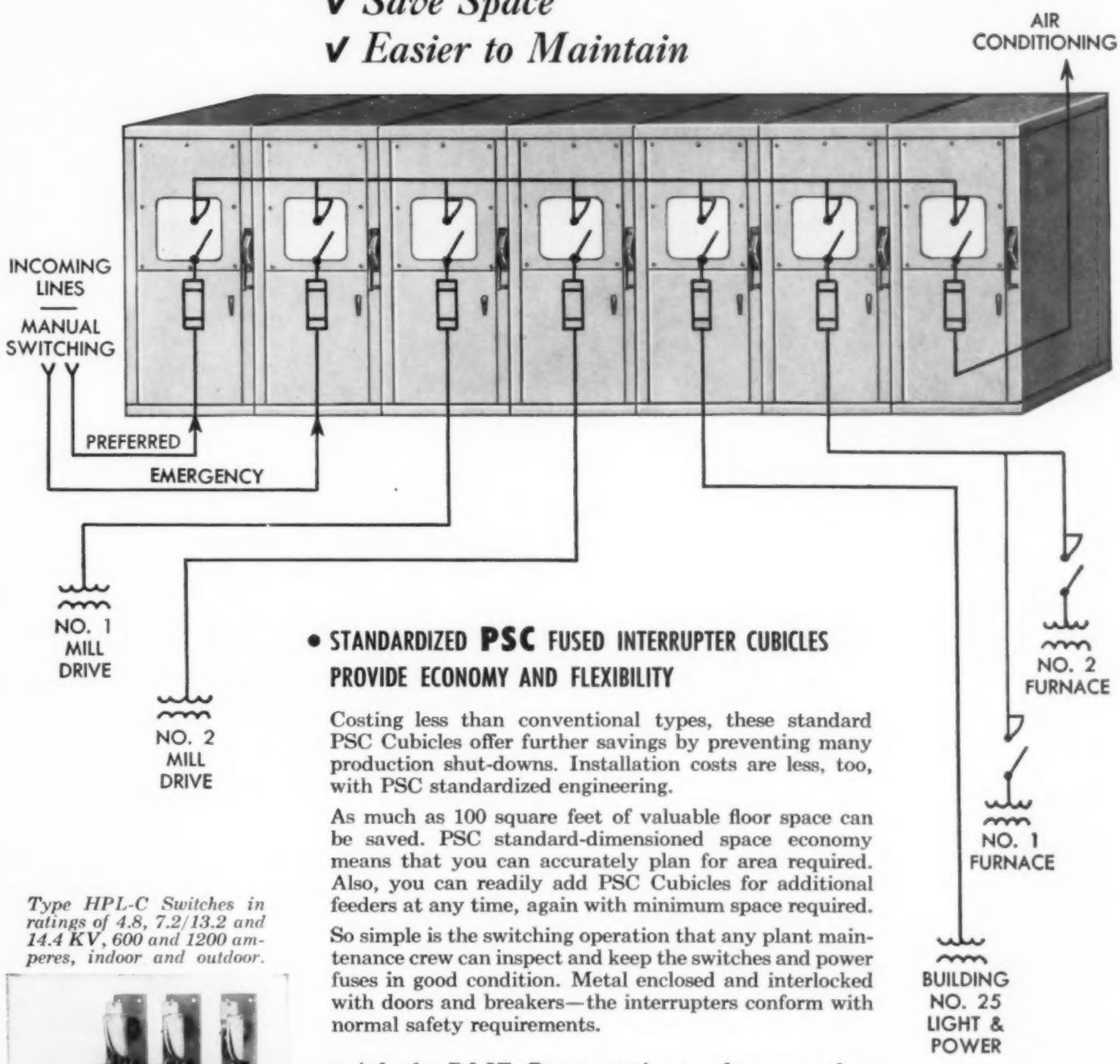

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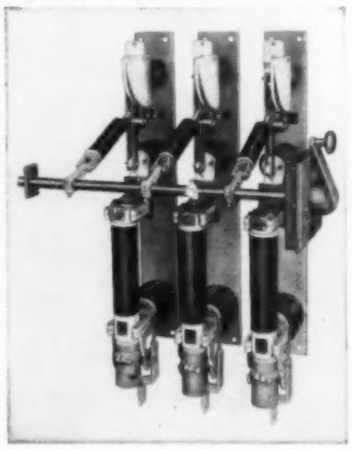

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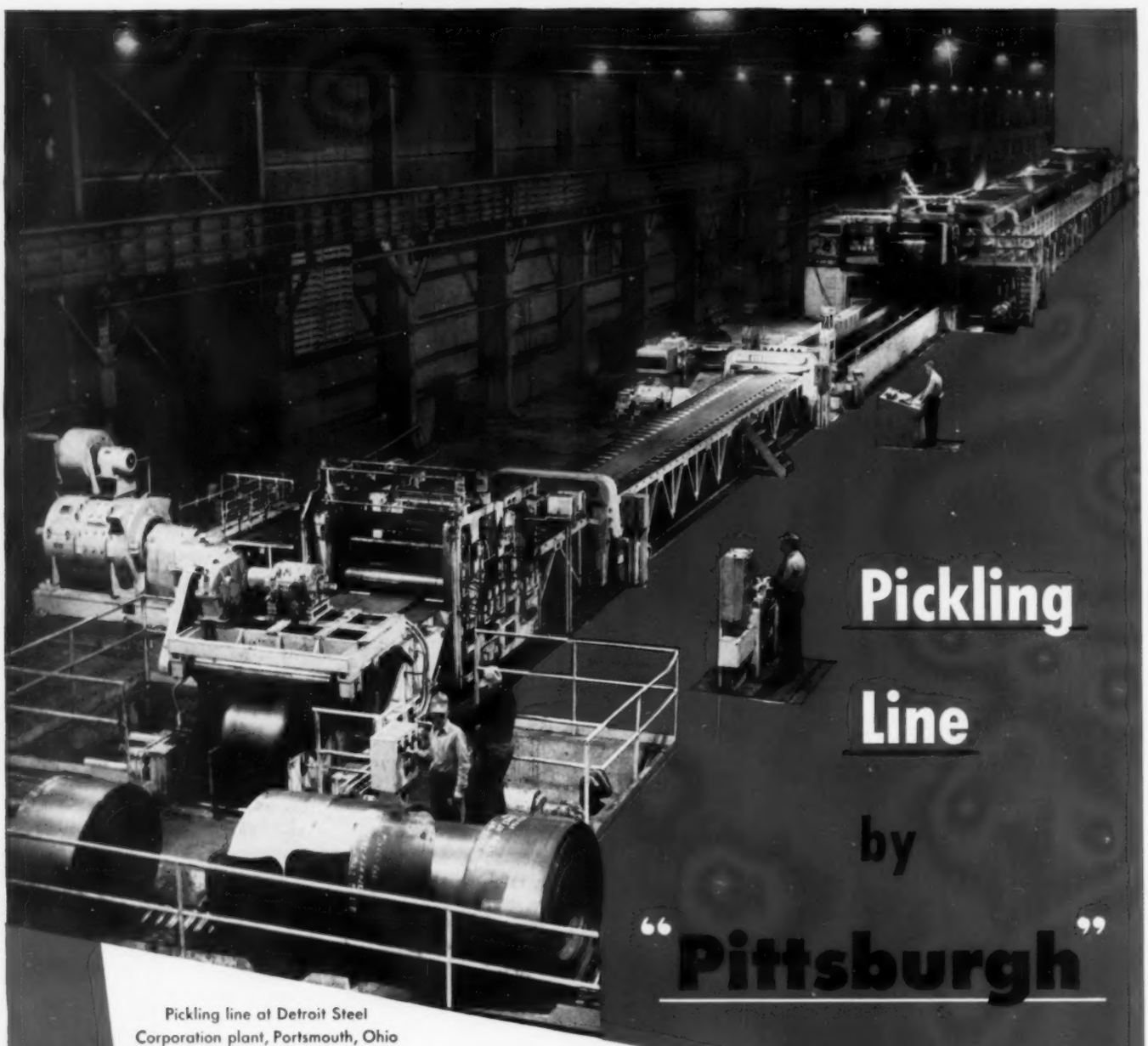

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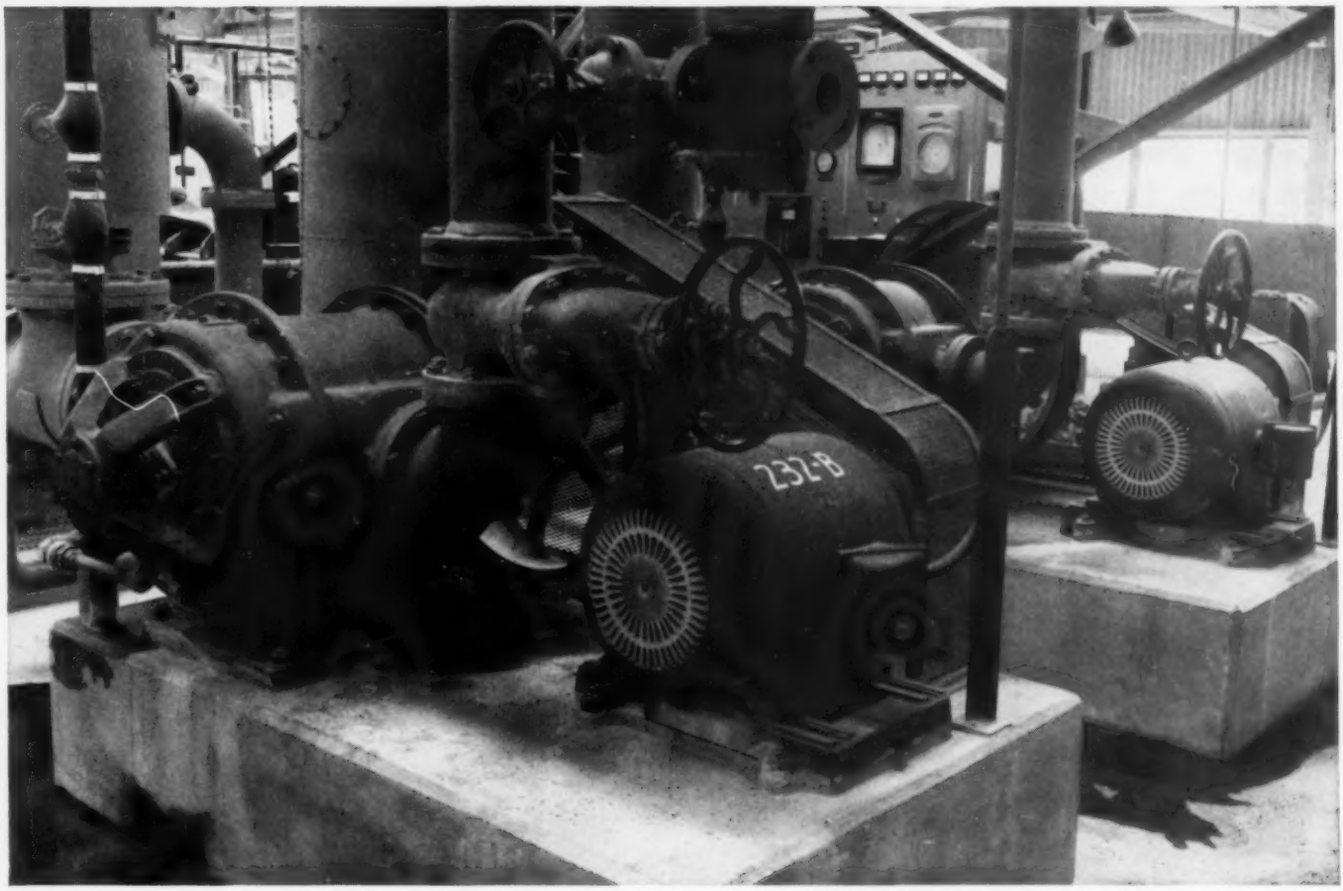

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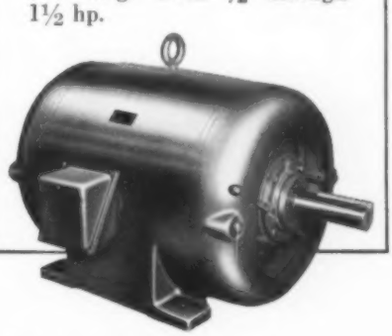

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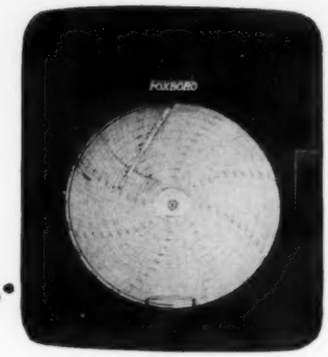

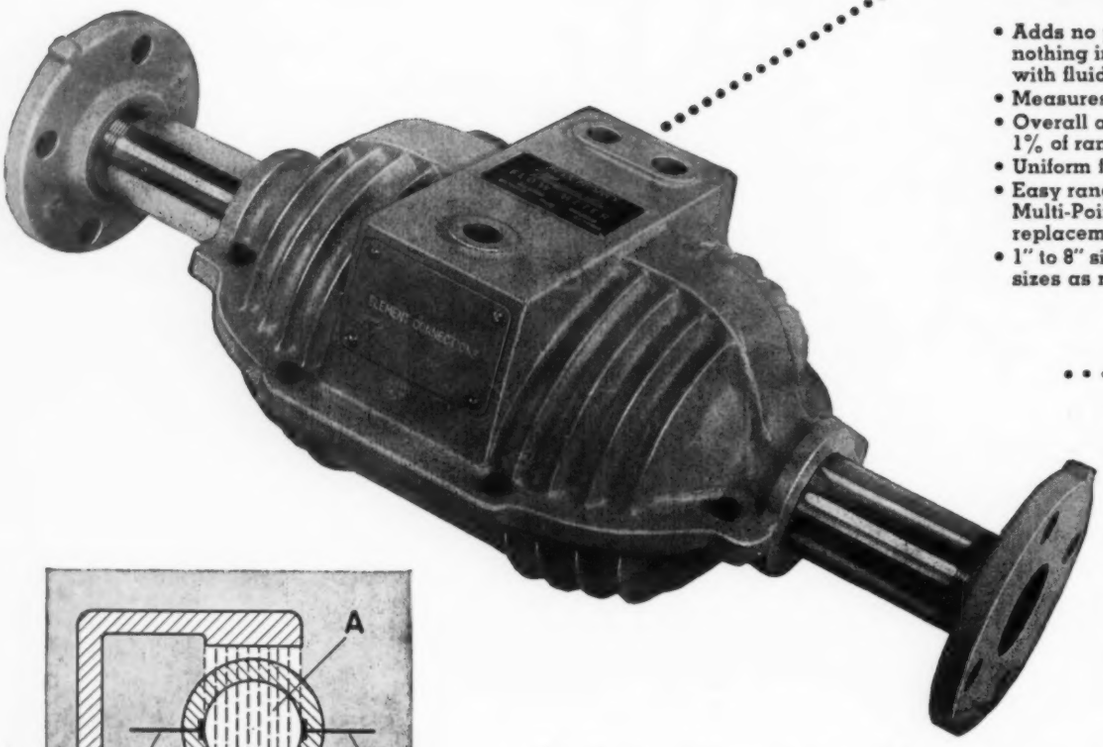

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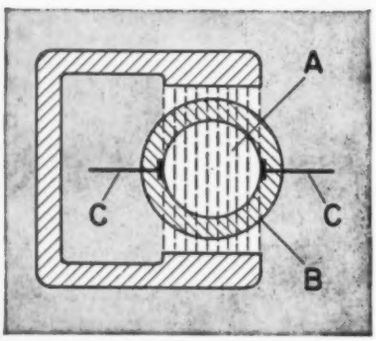

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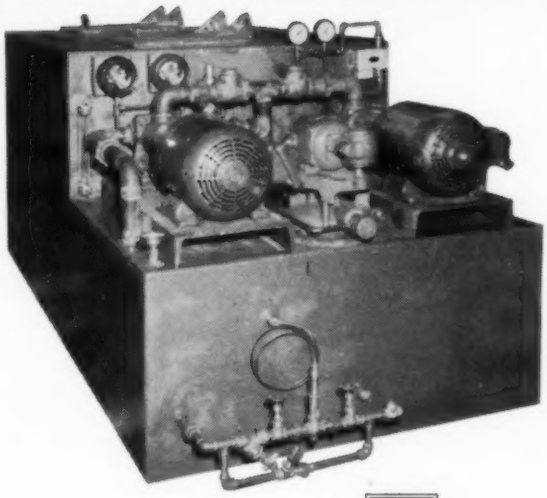

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Piping, elbows and valves are carefully selected to hold pressure drops to a minimum and to provide non-turbulent flow.

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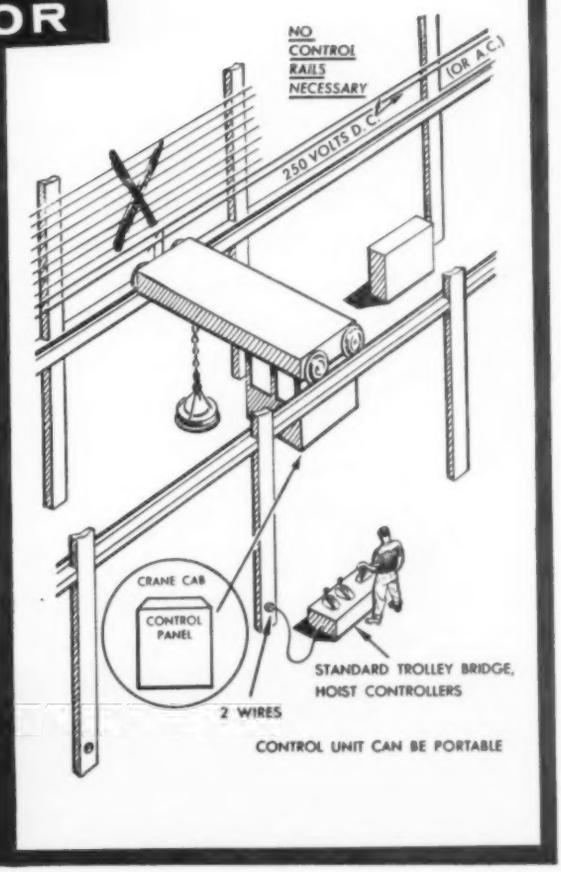
OPERATE YOUR CRANES FROM THE PLANT FLOOR

New Femco Remote Crane Control Systems

- EASY TO INSTALL
- EASY TO OPERATE
- SAVE TIME AND MONEY

You can raise or lower the hoist (5 positions), position the trolley forward or reverse (3 positions), travel forward or reverse (3 positions) and energize or turn off the magnet—all from the plant floor.

As carrier current over existing power rails is the only circuit required, installation is simple. By use of different frequencies, several cranes can be controlled on one power circuit.



Get the facts—talk it over with a Femco sales engineer

Femco

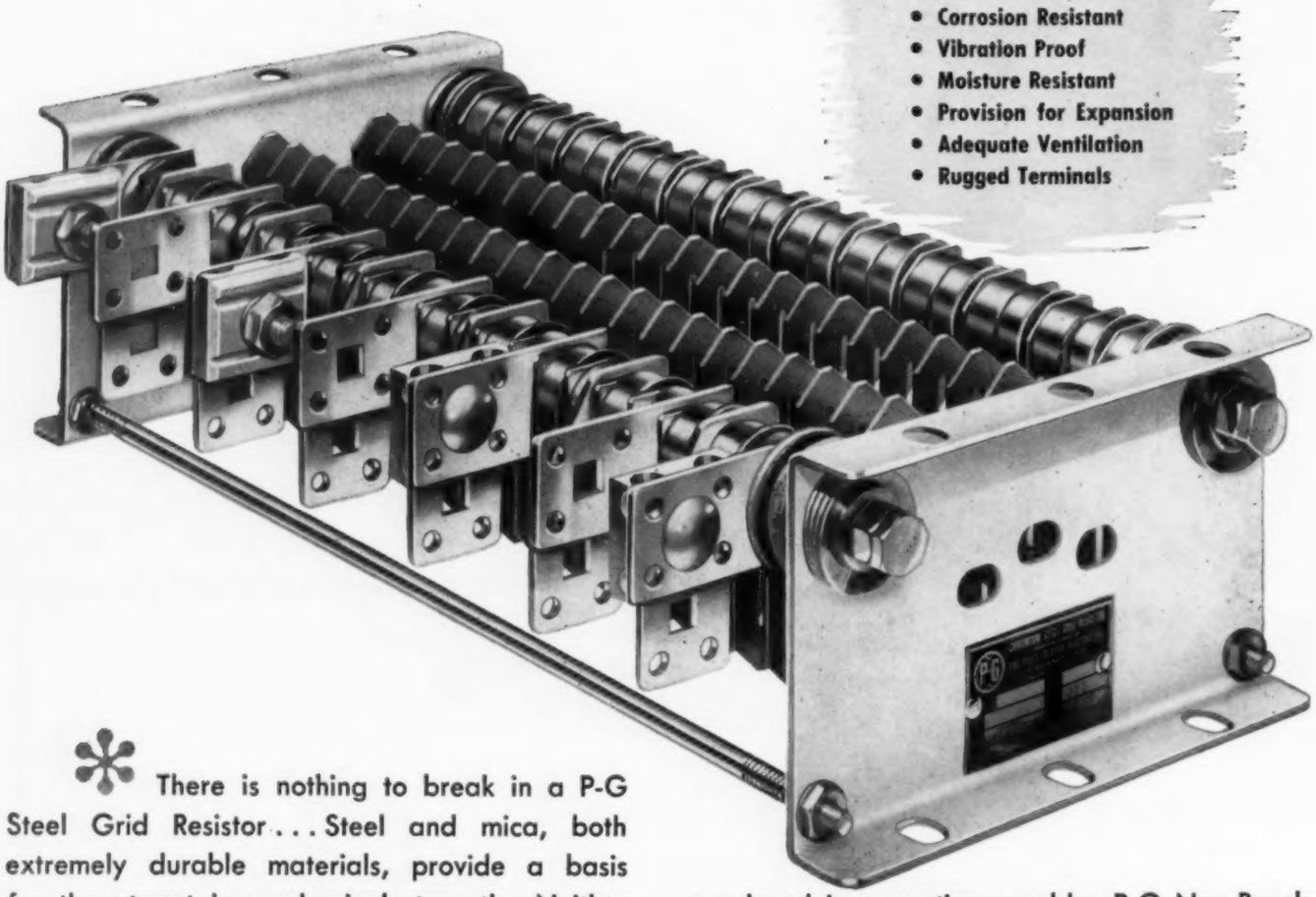
FEMCO, INC.
IRWIN, PENNSYLVANIA
Telephone UNderhill 3-3200

Specialists in Electronic Communication and Automation for Industry

BUILT OF *Steel* AND *Mica*

NOTHING TO BREAK . . .

- Steel Construction
- Mica Insulation
- Corrosion Resistant
- Vibration Proof
- Moisture Resistant
- Provision for Expansion
- Adequate Ventilation
- Rugged Terminals



There is nothing to break in a P-G Steel Grid Resistor . . . Steel and mica, both extremely durable materials, provide a basis for the utmost in mechanical strength. Neither do vibration, nor moisture laden or corrosive atmospheres have material effect on P-G Resistors . . . This, together with provision for expansion as well as efficiency in dissipating heat produced in operation, enables P-G Non-Breakable Resistors to give long and trouble-free service . . . The next time that troublesome application is at hand, specify P-G and solve your maintenance problem.

Write for Bulletin No. 500

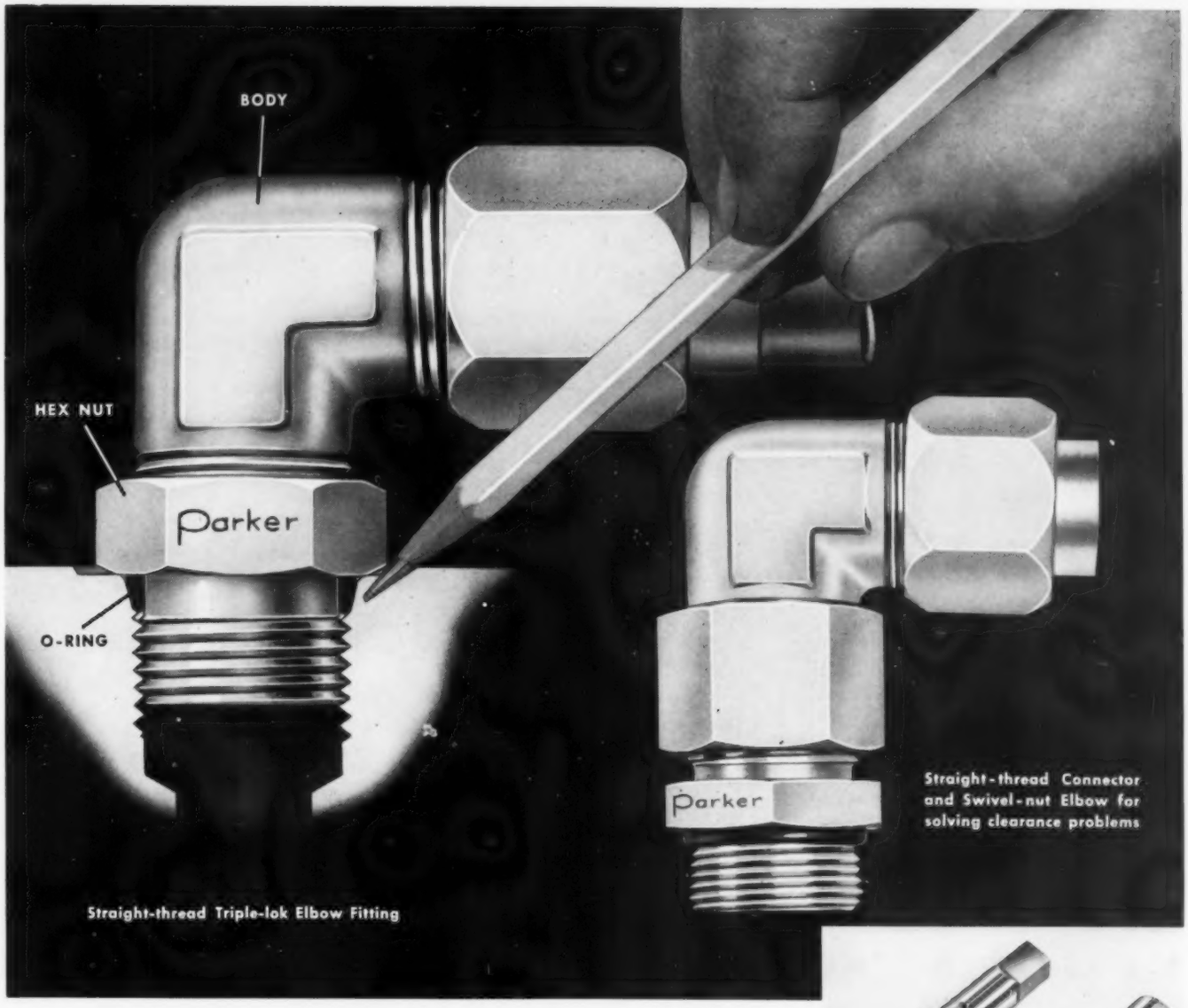
P-G

The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO



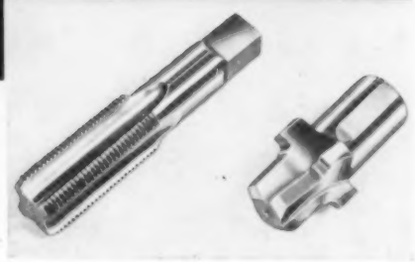
New Parker *straight*-thread fittings solve your leakage problems

Now you can forget about high-pressure hydraulic problems resulting from tapered pipe threads. Forget about leakage . . . about the danger of cracking or distorting valve bodies by over-tightening the fittings . . . about damaged threads from over-tightening to obtain proper positioning. Forget about messy pipe "dope".

You can eliminate all of these problems by using new Parker *straight*-thread fittings with positive O-ring seals. (See illustration above.)

Parker *straight*-thread fittings are now being supplied in response to the growing demand for this new type of leakproof, trouble-free connection. They are shorter and have smaller hexes than the AN fitting for the old AND 10050 boss. *Straight* threads are available on *Triple-lok* (the industrial standard flare tube fitting) and on *Ferulok* (flareless fitting for heavy steel tubing).

This is another example of Parker's pioneering leadership in the field of hydraulic fittings. Mail the coupon today for complete information.



Precision thread-tapping and counterboring tools for making accurate *straight*-thread boss (to receive these new Parker *straight*-thread fittings) are now available with machining drawings from Parker.

Parker

Hydraulic and fluid system components

TUBE AND HOSE FITTINGS DIVISION
Section 412-L

The Parker Appliance Company
17325 Euclid Avenue
Cleveland 12, Ohio

Send Catalog 4301.

Name_____

Company_____

Address_____

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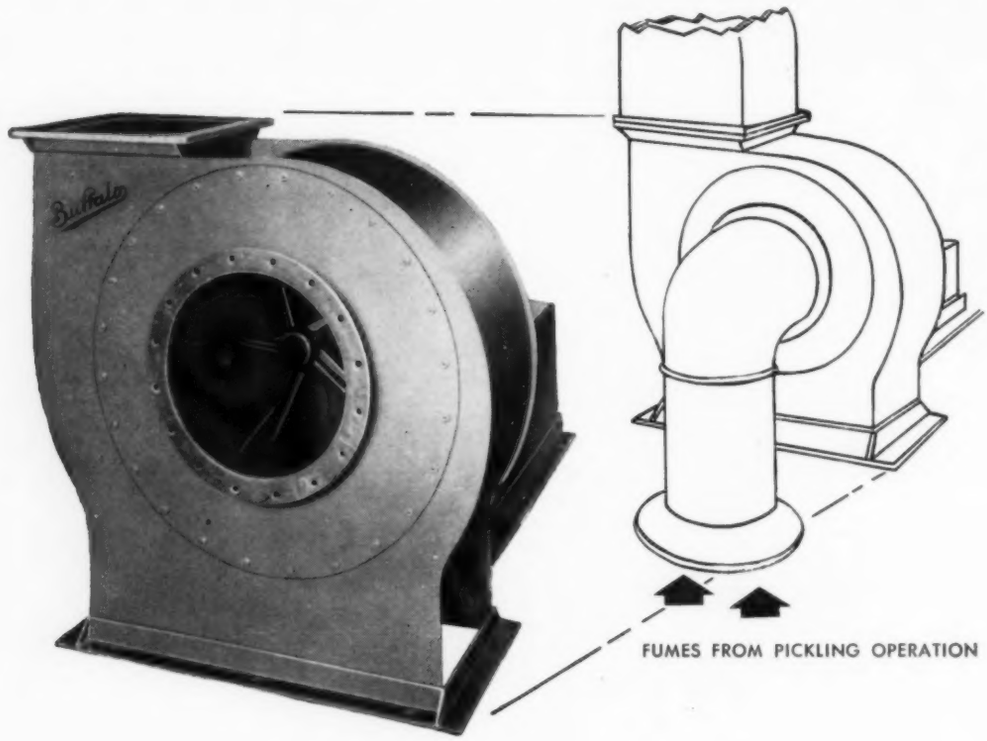
WHY "PICKLE" THE EXHAUST FAN, TOO?



MAKE IT A "BUFFALO" RUBBER-LINED EXHAUSTER AND SAVE REPLACEMENTS

Actually, an ordinary metal exhauster handling pickling fumes is getting a continuous pickling — without rinsing and washing. These fan-eating fumes cause all-too-frequent expenses where they hurt most — in exhauster replacements.

"Buffalo" Rubber-Lined Exhausters are not new — they've been giving 3 to 12 times longer fume-handling service for the past 25 years. Whatever corrosive fume you handle, it never touches metal — because a protective rubber blanket is vulcanized to every square inch of the inside of the fan. "Buffalo" Rubber-Lined Fans more than pay for their extra cost in fan replacements, without beginning to count reduction of down-time. WRITE FOR BULLETIN 2424-E and see the many "plus" features that add up to the famous "Buffalo" "Q" Factor*, or extra value.

**The "Q" Factor — the built-in Quality which provides trouble-free satisfaction and long life.*

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PUBLISHERS OF "FAN ENGINEERING" HANDBOOK

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VENTILATING AIR CLEANING AIR TEMPERING INDUCED DRAFT EXHAUSTING FORCED DRAFT COOLING HEATING PRESSURE BLOWING

at last . . . the solution to

really tough gas-cleaning problems

Sub-micron fumes are the *really tough* problems in gas cleaning. These fumes cannot be economically or effectively controlled by conventional cleaning devices.

However, the CHEMICO P-A VENTURI SCRUBBER is proving its success in solving these *really tough* problems in more than 150 commercial installations and in more than 70 pilot investigations.

The table lists some of these commercial installations. All of these *really tough* problems and many more are being solved with complete satisfaction to users of P-A VENTURI SCRUBBERS.

PROCESS	DUST OR FUME	INSTALLED CAPACITY CFM
Incinerator—Flue Fed	Fly Ash	32,000
Incinerator—Sodium Disposal	Na_2O	9,000
Incinerator—Industrial	Radioactive Dust	6,000
Dry Ice & CO_2 Plants	Amine Recovery	72,400
CO_2 Gas for Process	Fly Ash	500
Boiler Flue Gas	Fly Ash & SO_2	4,300
Enamel Frit Furnace	Dust & HF	11,900
H_2SO_4 Concentrator	H_2SO_4	49,800
Copperas Roasting	H_2SO_4	34,250
Cobalt Ore Roasting	H_2SO_4	65,000
Chemico Wet Type Acid Plant	H_2SO_4	41,000
Chloro-Sulfonic Plant	H_2SO_4	600
Phosphoric Acid Plant	H_3PO_4	91,900
Phosphoric Acid Concentrator	H_3PO_4	194,000
Phosphor Copper Furnace	H_3PO_4	15,000
Smelting—Non-Ferrous		
Blast Furnace	Lead & Organic	12,000
Reverb. Furnace	Lead Compounds	23,500
Comb. Blast & Reverb.	Lead Compounds	7,000
Brass Furnace	Zinc Oxide	7,500
Ajax Furnace	Beryllium Fumes	4,000
Steel Plant		
Oxygen Steel Process	Iron Oxide	140,000
Blast Furnace	Coke & Iron Oxides	788,000
Zinc Sintering	Zinc Oxide	75,000
Wood Distillation	Tar Products	3,500
Na_2SiF_6 Dryer	SiF_4 & Dusts	700
Iron Chloride Concentrator	$FeCl_2$ & HCL Mist	40,000
Unknown	Carbon Black	1,700
Lime Kiln	Lime & Na_2O	18,000
Detergent Spray Dryer	Chemical Fume	250,000
Furfural Residue Burner	Fly Ash	36,000
Nodulizing Kiln	Manganese & Lead	25,000
Aluminum Pot Lines	Tar Fog, Fluorides	40,000
Carbide Furnace	Metal Oxides	1,000
Asphalt Plant	Rock Dust	80,000

Write to our P-A Sales Department for Bulletins

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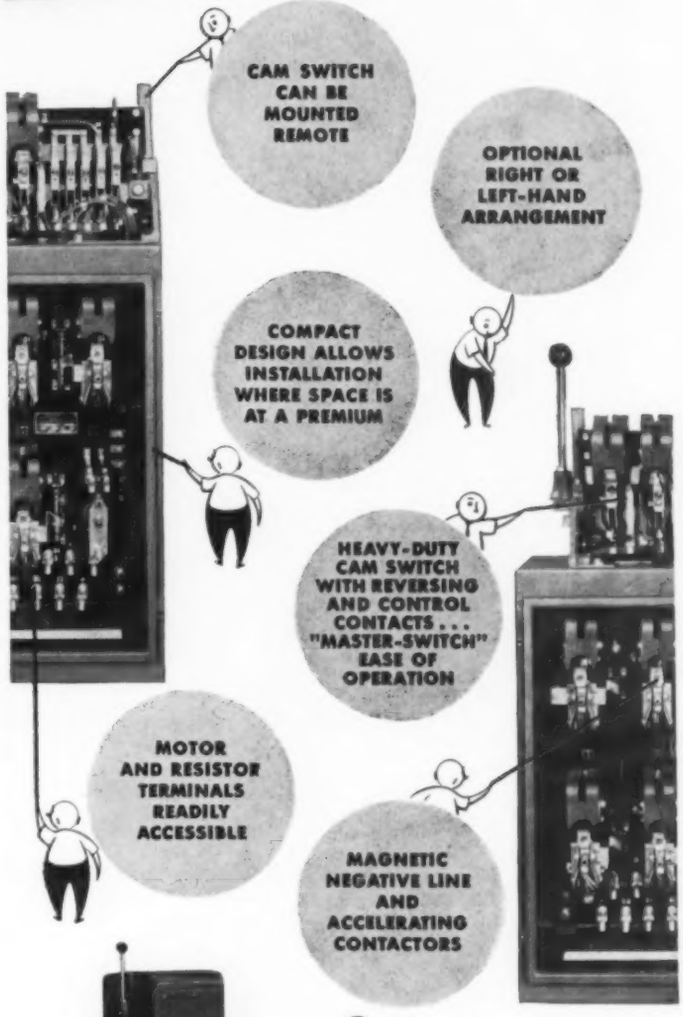
HEAVY-DUTY D-C MAN-NETIC CONTROLLERS*

COMBINATION MANUAL and MAGNETIC CONTROLLER FOR CRANES—CHARGING MACHINES—D-C CONTROL JOBS


CAM SWITCH CAN BE MOUNTED REMOTE
OPTIONAL RIGHT OR LEFT-HAND ARRANGEMENT
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HEAVY-DUTY CAM SWITCH WITH REVERSING AND CONTROL CONTACTS . . . "MASTER-SWITCH" EASE OF OPERATION
MOTOR AND RESISTOR TERMINALS READILY ACCESSIBLE
MAGNETIC NEGATIVE LINE AND ACCELERATING CONTACTORS

2 TYPES AVAILABLE: REVERSE-PLUGGING OR DYNAMIC - LOWERING

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For more information, contact our representative in your area, or write or call THE EUCLID ELECTRIC & MFG. CO., MADISON, OHIO.

Ask for Bulletin 4400-4401.

*PATENT APPLIED FOR.

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M. W. CLEMENT

Portrait by Fabian Bachrach

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"Out of association with the Advisory Committee has come the understanding of how interested most chief executives are in the well-being of their employees.

"It is almost inevitable that when the chief executive has this interest, employees have an easy opportunity to buy 'E' Bonds through the Payroll Savings Plan."

M. W. CLEMENT, ***Chairman of the Board Pennsylvania Railroad***

Mr. Clement's interest in employee security and Payroll Savings extends beyond his company's Payroll Savings Plan. As a member of the Treasury Payroll Savings Industrial Advisory Committee, Mr. Clement gives freely of his time and counsel to the expansion of the Payroll Savings Plan throughout industry and business.

Your State Director will help you build a Payroll Savings Plan *you* can be proud of. Write to Savings Bond Division, U.S. Treasury Department, Washington 25.

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IRON AND STEEL ENGINEER

2 High Hot Strip Mill Table Rolls in plant of Dominion Foundries and Steel Ltd., Hamilton, Ontario, Canada. Arrows indicate location of J-M Clipper Oil Seals which protect bearings against dirt and other adverse conditions

Engineers at Dominion Foundries and Steel Hot Strip Mill report:

"Bearings better protected— damaging dirt sealed out with Clipper Seals"

TABLE ROLLS of the 2 high strip mill at Dominion Foundries and Steel Ltd. must operate efficiently despite severe service conditions. Life of the Roll Bearings is constantly threatened by dirt and salt from strip mill operations.

To provide better protection, engineers replaced the original bearing seals with J-M Clipper Oil Seals. Long after this installation was made, Clipper Oil Seals are still providing far better bearing protection than the material formerly used. They seal out mill scale, salt and other foreign matter which might work into the bearing housings. They remain efficient despite high oil and air temperatures. They protect bearings by assuring clean lubrication.

Clipper Oil Seals offer many advantages wherever accurate fit, longer life and greater sealing effectiveness are required. These precision-moulded oil seals provide easy installation because the tough, dense heel affords just the right amount of rigidity for a press fit in the cavity . . . while the flexible lip, held in light but positive contact with the shaft by an especially designed garter spring, provides effective sealing at all times.

Made in both split and endless types, Clipper Oil Seals are available in a wide variety of designs, to meet practically any sealing requirement. For complete details and literature write Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay St., Toronto 1, Ont.

JOHNS-MANVILLE JM PRODUCT

Johns-Manville CLIPPER OIL SEALS

VOTE + but

Study the issues and the candidates—and then decide where you stand

You wouldn't buy a new car without at least driving it around the block.

You wouldn't buy a new house without checking up on the neighborhood, the schools, and any back taxes.

So vote—but don't vote in the dark in this exciting election year.

Listen to what candidates are saying on TV and radio.

Read your newspapers—especially the political news and editorial page.

Talk things out with your neighbors over the back fence and at the filling station on the corner. Take part in the discussion group at your church, club, lodge, or school.

Think about the issues and the candidates—and then make up your own mind. Remember, nobody is in that voting booth but you and your conscience. Step behind that curtain with pride on election day. Then vote as a free American.

VOTER'S CHECKLIST

1. Be sure you're registered.

2. Study the issues and candidates. Go to rallies. Ask questions. Read the papers. Listen to speeches.

3. Mark up a sample ballot in advance. (They are published in the papers.)

4. Join your neighbors at the polls on Election Day November 6th.

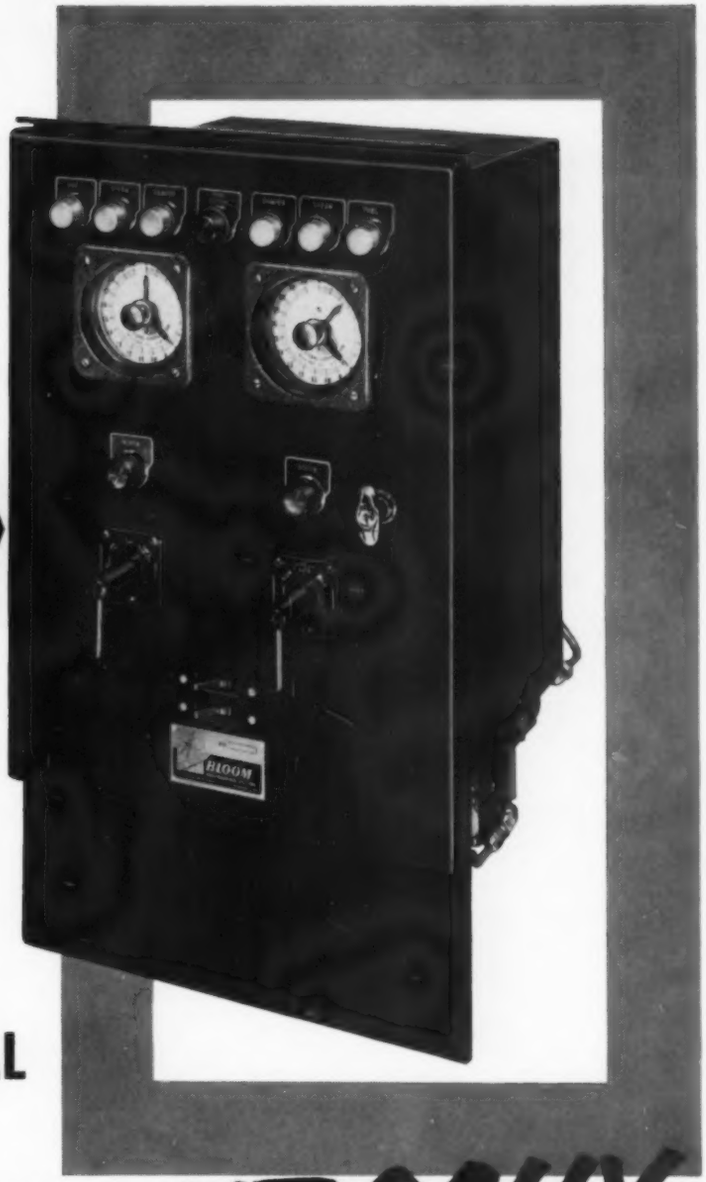
Is your name in the book?

You can't vote if you're not registered. You lock yourself out of the polls, unless you're a registered voter. And you and only you can get your name in the Registration Book. When they call the roll on election day, will you be there? Do you know anyone who won't?

THE AMERICAN WAY OF LIFE IS WORTH DEFENDING

PUBLIC SERVICE ADVERTISING COUNCIL

The BLOOM Time-Cycle Reversal Unit



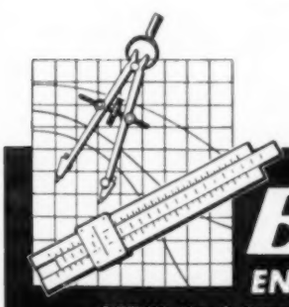
assures

FULL, FAST AND EFFICIENT REVERSAL OF REGENERATIVE FURNACES AUTOMATICALLY

This complete, compact, factory-tested unit provides a combination electric-pneumatic system for Open Hearth Furnace and Soaking Pit reversal. It eliminates reversal puffing and shortens reversal period. (10 to 15 seconds easily accomplished).

Shorter reversal cycle improves furnace life.

These units have been in continuous service for nine years. Trouble-free maintenance.



BLOOM ENGINEERING CO., INC.

857 W. North Avenue Pittsburgh 33, Pa.

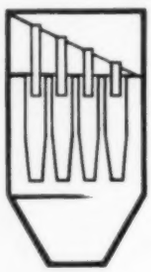
WRITE or phone for complete information on the Bloom Time-Cycle Reversal Unit.

The industry's most experienced organization in dust, fume and fly ash recovery

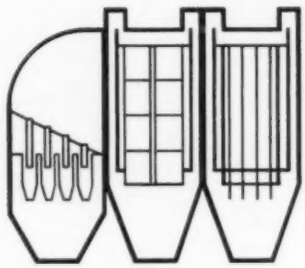
—as near as your telephone!

Because the Western Precipitation Corporation stands alone in its years of continuous leadership in the complex science of recovering suspensions from industrial gases, Western Precipitation installations, quite naturally, are recognized throughout the world as the best obtainable. . .

■ Almost a half-century ago—in 1907 to be exact—Western Precipitation installed the first commercial application of the now-famous Cottrell Electrical Precipitator—and has more know-how, more varied experience and application background in world-wide installations in this type of equipment than any other organization, domestic or foreign.



■ Many years ago Western Precipitation was first again with the multiple small-diameter tube type of cyclonic collector—the type with higher centrifugal forces for greater recovery efficiencies. And through the years, Western Precipitation engineers have continuously led in new advancements, new refinements in the *mechanical* recovery field as well as in *electrical* recovery methods.



■ Western Precipitation was the first to combine Electrical and Mechanical recovery advantages in one compact, coordinated system—the CMP (Combination Multiclone—Precipitator) Unit. This equipment, offering almost constant collection efficiency despite varying gas volume, requires years of experience in both electrical and mechanical recovery methods for proper operating "balance".

. . . only Western Precipitation has had such extensive experience in basic recovery methods!

These are only a few of the many important reasons why a Western Precipitation installation is recognized as the best obtainable. This unequalled know-how is quickly available throughout the major industrial areas of the United States and Canada from strategically-located, fully-staffed offices and field representatives, as shown at right. There's one as near as your telephone.
So before you finalize any dust, fume or fly ash recovery plans, be sure to find out the vital *extra* advantages offered by Western Precipitation Corporation!

For literature describing Western Precipitation's unique background of experience and advancements, phone, wire or write our nearest office.

COTTRELL Electrical Precipitators
MULTICLONE Mechanical Collectors
CMP Combination Units
DUALAIRE Reverse-Jet Filters
HOLO-FLITE Processors

Western Precipitation Corporation

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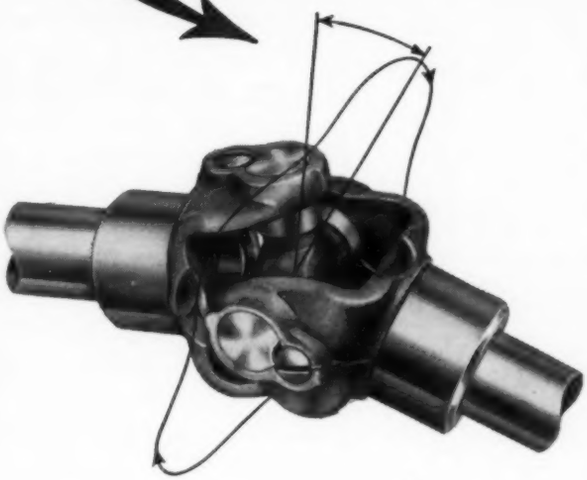
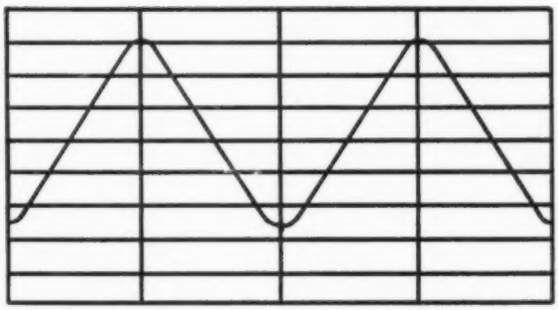
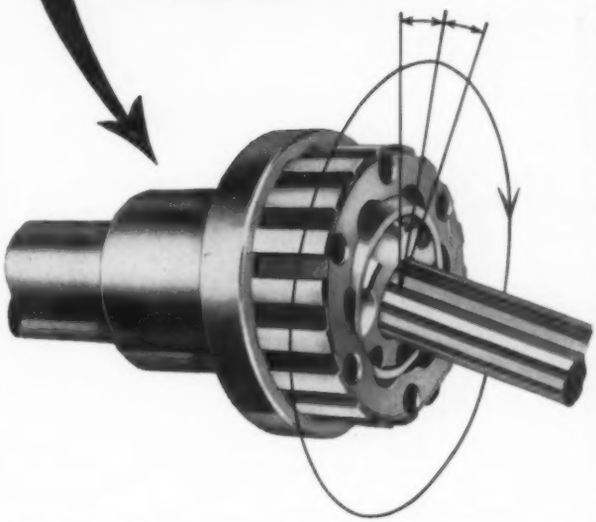
This Action Costs You Money

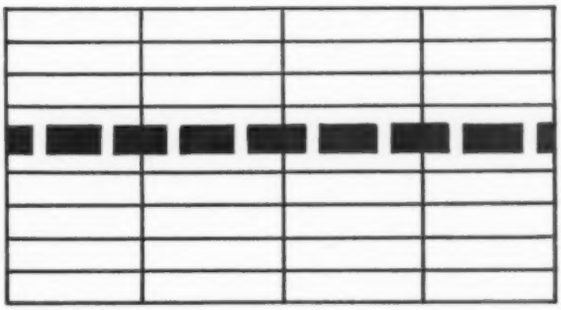




During rotation at a given angle, pin or slipper-type joints speed up, slow down twice during one revolution, as shown by the solid line in the graph.

This Action Saves You Money





Rzeppa Joints *always* transmit torque smoothly, even at unbalanced angles. Note constant velocity of 100% for Rzeppa Joint (dotted line).

Are You Getting The Most Out Of Your Rolling Equipment?

The simple illustration above shows how Rzeppa Constant Velocity Joints transmit torques smoothly —and profitably—on many of today's most advanced mills.

Steel-producing equipment of all types can take advantage of Rzeppa's unique design. It makes possible these money-saving features:

- INCREASED SPEEDS
- REDUCED DOWN-TIME
- LOWER MAINTENANCE
- GREATER ANGLES

Why not investigate? Write today for descriptive literature.

SEE BOOTHS 525-526 IRON AND STEEL EXPOSITION

RZEPPA "SHEPPA"

CONSTANT VELOCITY UNIVERSAL JOINTS

THE GEAR GRINDING MACHINE COMPANY

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Manufacturers of: Fully Automatic Gear Grinding Machines • Detroit Screwmatic 750 single spindle screw machine.

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(*Continued from page 320*)

aspects of plant corrosion and protective measures. Presented in detail are the plant inspection department procedure, inspection procedure, corrosion and protection of oil equipment, calculations, and general safety procedures. The book is additionally well amplified by photographs, sketches, tables, and charts.

"ABACS or Nomograms" by A. Giet (English Edition) has recently been published by the Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. This book was translated from the French by Miss Helen Phippen and edited by J. W. Head. The book contains 225 pages, 8½ x 5½ in., is cloth bound, and sells for $12.00. Unlike most of the literature on this subject, this book is not written solely for mathematicians. This work is practical and demonstrates the many and varied applications of the nomogram. It shows how those without highly specialized mathematical knowledge may construct charts. Both Cartesian abacs and alinement charts are discussed, and a large number of examples drawn from the fields of mechanics, physics, and electrical engineering are employed. Very few formulae are outside the scope of nomograms if skillfully chosen auxiliary variables are introduced. This edition should be of interest to engineers and physicists, etc., who require time-saving methods when performing repetitive and complicated calculations.

"Introduction to Plasticity" by Aris Phillips, Associate Professor of Civil Engineering, Yale University, has recently been published by the Ronald Press Co., 15 East 26th Street, New York 10, N. Y. The book contains 229 pages, 6 x 9 in., is cloth bound, and sells for $7.00. The book consists of nine chapters, the first six dealing with one-dimensional problems, the last three consider problems of combined stress; the concept of a tensor, necessary only in advanced work, is not discussed. Eighty-seven problems are contained in the text, proofs of theorems are provided in an appendix, theoretical analyses in developing rational, consistent methods are stressed, latest methods of calcu-

(*Please turn to page 346*)

OPPORTUNITY FOR METALLURGISTS

Stoody Company, top manufacturer of hard-facing alloys (as welding electrodes, rods and wires and as alloy castings), needs metallurgists. The positions involve product quality control, research and development, preparation of technical papers and articles, handling of technical correspondence and some field work. Previous experience in the hard-facing field is desirable but not indispensable. Applicants should have a B.S. degree and a thorough working knowledge of welding processes and techniques.

Salary will be commensurate with education and experience. Beside the usual medical benefits and vacations with pay, we have an excellent profit sharing and retirement plan.

The Stoody plant is located near Whittier, a civic minded community of well kept homes, good schools and churches of all faiths. Los Angeles, a leading cultural and entertainment center, is only fourteen miles away. Within short driving distance are 7000 ft. mountains and excellent bathing beaches.

If you feel you can contribute profitable and usable ideas and would like to be a part of an aggressive organization, address a letter to W. Schumert, General Manager, Box 901, Whittier, California, giving your qualifications, age, present salary and any other information you think we might want. Correspondence will, of course, be held in strictest confidence.

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BOOK REVIEWS

(*Continued from page 344*)

lating stresses and strains are considered, present-day research and the importance of metal plasticity to the stress analyst are emphasized. Numerous illustrative examples and diagrams are integrated in the text.

"**Cooling Electric Machines and Cables**" by Theordore De Konig has been recently published by the author, % Zuid Nederlandsche Durkkery, s'Hertogenbosch, Holland. The book contains 233 pages, 9 x 6 in., is cloth bound, edition in blue cover sells for $5.00, and the "Electrical Manufacturers Edition, red cover, is $15.00. The book is a compilation of eight papers on cooling of electric machines and equipment. One paper covers steel mill drives.

INDEX TO ADVERTISERS

SEPTEMBER, 1956

A

Adalet Manufacturing Co., The 314
Adams Co., Inc., R. P. 326
Aetna-Standard Engineering Co. 1
Air Products, Inc. 268
Air Reduction Sales Co. 253
Ajax Flexible Coupling Co. 255
Alliance Machine Co. 296
Allis-Chalmers Manufacturing Co. 52, 53, 219
Alter Co., The 204
American Air Filter Co. 282
Ampco Metal, Inc. 258
Askania Regulator Co. 67
Atlas Car and Manufacturing Co. 300

B

Babcock and Wilcox Co., The 19
Bailey Co., William M. 240
Bailey Meter Co. 275
Bearings, Inc. 321
Berry Bearing Co. 41
Bethlehem Steel Co. 28
Birdsboro Steel Foundry and Machine Co. 35
Blaw-Knox Co., Foundry and Mill Machinery Division 12, 13, 306
Bliss Co., E. W. 7
Bloom Engineering Co., Inc. 341
Bristol Co., The 246
Brown Fintube Co. 25, 27
Browning and Co., Inc., Victor R. 55
Buffalo Forge Co. 336

C

Chemical Construction Corp. 337
Cities Service Oil Co. 304
Clark Controller Co. 295
Clark Equipment Co., Industrial Truck Division 58
Cleveland Crane and Engineering Co. 68
Cleveland Worm and Gear Co. ..... Cover 3
Columbus McKinnon Chain Corp. 313
Corhart Refractories Co. 207
Cowles Tool Co. 318
Crouse-Hinds Co. 252
Cutler-Hammer, Inc. ..... Cover 2

D

De Laval Steam Turbine Co. 315
Delta-Star Electric Division, H. K. Porter Co., Inc. 234
Documentation and Licenses, Paris, France 72
Dodge Manufacturing Corp. 326
Dowell, Inc. 216
Dravo Corp. 18, 271, 333
Drever Co. 292
Duraloy Co., The 298

E

Eichleay Corp. 6
Electric Controller and Manufacturing Co., Division Square D Co. 11, 221, 222, 223, 224
Electric Furnace Co., The 326
Electric Service Works, Delta-Star Electric Division, H. K. Porter Co., Inc. 248, 249
Elliott Co. 42, 43
Euclid Electric and Manufacturing Co. 337
Exide Industrial Division, Electric Storage Battery Co. 267

F

Feller Engineering Co. 60
Femco, Inc. 333
Flinn and Dreffein Engineering Co. 72
Foxboro Co., The 332

G

Garlock Packing Co., The 261
Gear Grinding Machine Co. 343
General Electric Co. 4, 5, 48, 70, 71, 264, 316, 317
Gulf Oil Corp. 32

H

Hagan Corp. 30, 31
Hallden Machine Co., The 72
Harnischfeger Corp. 322
Hazen Engineering Co. 50, 51
Heyl and Patterson, Inc. 29
Holophane Co., Inc. 8
Homestead Valve Manufacturing Co. 15
Houghton and Co., E. F. 210, 211
Hunt and Sons, Inc., C. B. 237
Hyatt Bearings Division, General Motors Corp. 302
Hyde Park Foundry and Machine Co. 324

I

Industrial Gear Manufacturing Co. 20
Ingersoll-Rand Co. 44
I-T-E Circuit Breaker Co. 34

J

Johns Manville Corp. 10, 339

K

Kaiser Aluminum and Chemical Corp. 301
Kane and Roach, Inc. 39
Koppers Co., Inc. 36, 37, 40, 291

L

Larco, Inc. 273
Lawrence Copper and Bronze Co. 320
Lectromelt Furnace Co. 74
Leeds and Northrup Co. 38, 344
Linde Air Products Co., Division Union Carbide and Carbon Corp. 325
Link-Belt Co. 14, 238, 239
Loewy-Hydropress Division, Baldwin-Lima-Hamilton Corp. 225
Loftus Engineering Corp. 214
Lubriplate Division, Fiske Brothers Refining Co. 314

M

Mackintosh-Hemphill Division, E. W. Bliss Co. 280
Mannesmann-Meer Engineering and Construction Co. 49
Manning, Maxwell and Moore, Inc. 33
Mansaver Industries, Inc. 226
Markal Co. 318
Master Builders Co., The 273
McDowell Co., Inc. 22
McKay Machine Co., The 260
McKiernan-Terry Corp. 299
Mesta Machine Co. 200, 201
Michigan Tool Co., Cone Drive Gears Division 236
Miles and Partner, John, London, Ltd. 72
Minneapolis-Honeywell Regulator Co. 256, 257
Morgan Construction Co. 212
Morgan Engineering Co., The 276
Murray Manufacturing Co., D. J. 293
Morgardshammars 254

N

National Bearing Division, American Brake Shoe Co. 262, 263
National Carbon Co., Division Union Carbide and Carbon Corp. 272, 283, 284, 285, 286, 287, 288, 289, 290
National Electric Coil Co. 21
National Roll and Foundry Co. 65
North American Manufacturing Co., The 220

O

Ohio Electric Manufacturing Co., The 323
Ohio Steel Foundry Co. 232
Osborn Manufacturing Co., The 274

P

Pangborn Corp. 250
Parker Appliance Co., The 335
Peerless Electric Co. 277
Pennsylvania Transformer Co. 259
Pittsburgh Engineering and Machine Co. 328
Pollock Co., William B. 319
Poole Foundry and Machine Co. 348
Post-Glover Electric Co. 334

R

R & I E Equipment Division, I-T-E Circuit Breaker Co. 327
Ramtite Co. 61
Refractory and Insulation Corp. 305
Reliance Electric and Engineering Co. 46
Roberts and Schaefer Co. 64
Rockwell Co., W. S. 293
Rollway Bearing Co., Inc. 278
Rust Furnace Co. 196
Rust-Oleum Corp. 9

S

Salem-Brosius, Inc. 281
Selas Corp. of America 231
Simmons Machine Tool Corp. 235
Spraying Systems Co. 54
Square D Co., Electric Controller and Manufacturing Division 11, 221, 222, 223, 224
Stamco, Inc. 47
Stearns Magnetic, Inc. 199
Stoody Co. 344
Sun Oil Co. 3
Surface Combustion Corp. 208, 209
Sutton Engineering Co. 245
Swindell-Dressler Corp. 62, 63

T

Taylor Chain Co., S. G. 303
Taylor Instrument Companies 213
Texas Co. ..... Cover 4
Timken Roller Bearing Co. ..... Cover 1
Tool Steel Gear and Pinion Co. 56, 57
Torrington Co., The 203

U

Union Carbide and Carbon Corp., Linde Air Products Co. 325
Union Carbide and Carbon Corp., National Carbon Co. 272, 283, 284, 285, 286, 287, 288, 289, 290
United Engineering and Foundry Co. 17
United States Graphite Co. 59
United States Steel Corp. 330, 331

V

Valley Mould and Iron Corp. 279
Vaughn Machinery Co., The 2

W

Wagner Electric Corp. 329
Waldron Corp., John 247
Wean Engineering Co., Inc., The 72
Wean Engineering Co. of Canada, Ltd., The 72
Wean Equipment Corp. 72
Wellman Engineering Co. 241, 242, 243, 244, 307, 308, 309, 310, 311, 312
Western Precipitation Corp. 342
Westinghouse Electric Corp. 227, 228, 229, 230
Wheelabrator Corp. 294
Wilson Engineering Co., Inc., Lee 16

Y

Yoder Co., The 45
Youngstown Alloy Casting Corp. 215
Youngstown Foundry and Machine Co., The 251
Youngstown Welding and Engineering Co. 66

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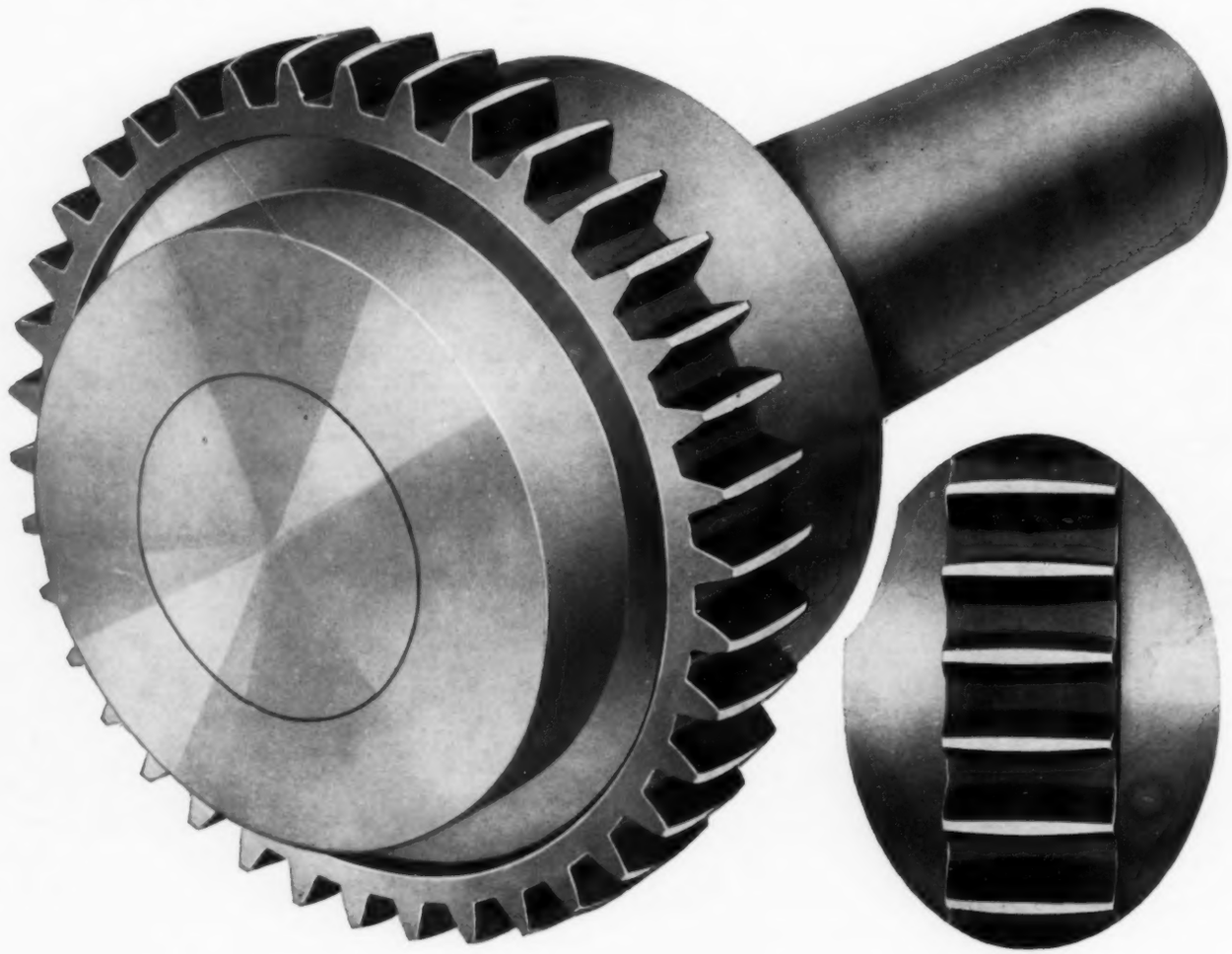

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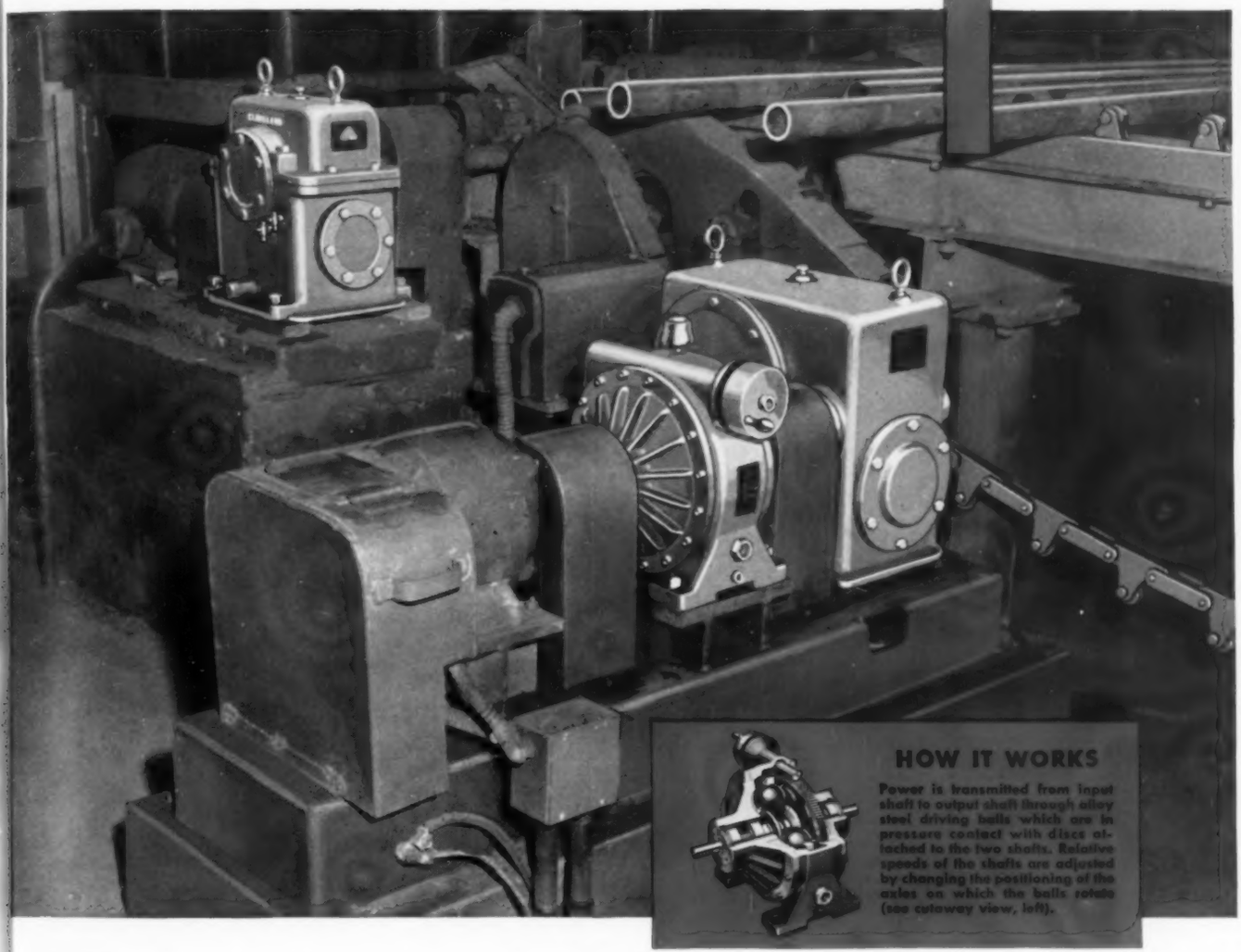

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